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Research Article

Hallux Abducto Valgus: A Systematic Review on the Effectiveness of Conservative and Non-Operative Treatments of the 1st Ray and Hallux Abducto Valgus Progression

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Abstract

Background: Hallux Abducto Valgus (HAV) is a very common, multifactorial, painful foot condition associated with a deformation of the big toe. Dysfunctions in the biomechanics of the first ray such as hypomobility or hypermobility have been suggested to play a key role in several foot conditions. Surgical interventions should be considered as a last option for patients presenting with hallux valgus. Many conservative, non-surgical treatments have proved inefficient, therefore there is scope for an innovative, non- surgical solution to reduce HV development and support proper foot function.

Research Question: The purpose of this study is to determine the availability and efficacy of the current non- surgical treatment modalities through a systematic review and to perform a systematic literature search to identify studies which have analyzed the effect of non-surgical foot appliances on hallux valgus, the effect of hallux valgus appliances on foot function, including muscle action, 1st ray biomechanics, hallux valgus angle and plantar pressure distribution, the effect of hallux valgus applications on pain, deformity and disability, to perform a quality assessment to identify the rigor of the identified studies.

Methods: The systematic review was conducted in PubMed in order to determine the availability and efficacy of present non-surgical treatment modalities for the control of the hallux valgus progression and for this investigation we used relevant search terms. We followed the Effective Public Health Practice Project Quality Assessment Tool recommendations for the assessment of risk of bias and the report was performed following the guidelines of Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA).

Results: Eight studies were eligible for selection. Hallux Abducto Valgus was the pathology to be evaluated with the use of soft and semi-rigid orthoses, taping, custom-made foot orthoses, static and dynamic orthoses. In most studies the reduction of the level of pain and the prevention of HAV progression was the effect of the non-surgical treatment.

Significance: It has been shown that the use of non-surgical treatment decreased the pain caused by HAV in most cases and in some it was shown that progression of the HAV deformity was prevented.

Keywords: Hallux valgus, medical devices for Hallux valgus, conservative treatment for HAV

Abbreviations

AOFAS: American Orthopaedic Foot and Ankle Society; EPHPP: Effective Public Health Practice Project; HAV: Hallux Abducto Valgus

Introduction

Hallux abducto valgus (HAV) has been defined as a progressive forefoot deformity of the great toe, which manifests hallux devia-

tion at the metatarsophalangeal joint [1,2]. This condition may as well result in the prominence of the first metatarsal head along with overlapping of the first and second toes [3,4].

The first ray comprises of the metatarsal and first cuneiform bones [5]. The role of pronation of the subtalar joint is to lower the first ray to the ground in order to stabilize it and absorb the heel impact. Thus, the medial longitudinal arch becomes stabilized through supination hence preparing the foot for the phase of propulsion [6,7].

Dysfunctions in the biomechanics of the first ray such as hypomobility or hypermobility have been suggested to play a key role in an amount of foot conditions [8-11]. About 90 years ago, Morton was the first to introduce the notion of first ray hypermobility known as "first ray insufficiency" and he suggested that this condition had an effect on the mechanics of the foot, which resulted in an excessive weight bearing of the second metatarsal [12-14].

Currently, the treatments that are available for hallux abducto valgus can be either surgical or non-surgical depending on each case [15,16]. The etiology of HV is multifactorial and can be classified into extrinsic and intrinsic factors. The most common extrinsic causes for hallux valgus deformity may be excessive weight, foot shape, and footwear selection, such as constrictive shoes with high heels or pointed shoes [17-19]. There are several intrinsic factors including contracture of the Achilles tendon, metatarsus primus varus, genetic predisposition, age and hypermobility of the first tarsometatarsal joint among others [18]. It has been suggested that another intrinsic factor for the progression of HV is an imbalance in muscle strength between the abductor hallucis (AbdH) and adductor hallucis (AddH) muscles in the foot [2,18].

Systematic reviews have been realized attempting to identify and determine the causes of forefoot pain as well the appropriate treatment in various populations. For example, a systematic review carried out by Aries-Martin and colleagues [20] determined that using custom-made foot orthotics played an important role in reducing the level of forefoot pain caused by HAV, among other pathologies. However, literature regarding the effectiveness of non-surgical HAV treatment is rather limited. Therefore, this review aims at identifying the availability and effectiveness of non-surgical treatments and their results on HAV.

Methods

We followed the recommendations provided in the Effective Public Health Practice Project Quality Assessment Tool [21] and used Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [22] guidelines, according to which the studies finally included in the review are shown in Table 1. A flow diagram was used in order to present the various stages of the selection process based on the one established by the PRISMA declaration. The time frame of the search was between August 2021 and October 2021.

Literature search: procedures of article selection

We performed the literature search in PubMed database, because of the broad inclusion of multidisciplinary topics within the Biomedical and Health Sciences domain. The search was conducted for all years included in the database with the last search completed in October 2021. There were no restrictions as far as the publication date or status was concerned and the descriptors consistent with the terms of interest as well as the free text terms were used; however, we included a few filters in order to narrow the outcome of the search. Specifically, we applied the parameter of human in species, Medline in Journals and searched the literature written in the English language. The results of the search were downloaded into an excel file. The search terms used for the selection of the articles to be used for were relevant to hallux valgus studies and non-surgical treatment and included Medical Subject Heading (MeSH) as well as text terms. ((("hallux valgus"[MeSH Terms] OR ("hallux"[All Fields] AND "valgus"[All Fields]) OR "hallux valgus"[All Fields]) AND ("equipment and supplies"[MeSH Terms] OR ("equipment"[All Fields] AND "supplies"[All Fields]) OR "equipment and supplies"[All Fields] OR ("medical"[All Fields] AND "devices"[All Fields]) OR "medical devices"[All Fields]) AND ("hallux valgus"[MeSH Terms] OR ("hallux"[All Fields] AND "valgus"[All Fields]) OR "hallux valgus"[All Fields])) NOT (("hallux valgus"[MeSH Terms] OR ("hallux"[All Fields] AND "valgus"[All Fields]) OR "hallux valgus"[All Fields]) AND ("surgery"[MeSH Subheading] OR "surgery"[All Fields] OR "surgical procedures, operative"[MeSH Terms] OR ("surgical"[All Fields] AND "procedures"[All Fields] AND "operative"[All Fields]) OR "operative surgical procedures"[All Fields] OR "general surgery"[MeSH Terms] OR ("general"[All Fields] AND "surgery"[All Fields]) OR "general surgery"[All Fields] OR "surgery s"[All Fields] OR "surgerys"[All Fields] OR "surgeries"[All Fields]))) NOT (("dysfunctional"[All Fields] OR

"dysfunctionals"[All Fields] OR "dysfunctioning"[All Fields] OR "dysfunctions"[All Fields] OR "physiopathology"[MeSH Subheading] OR "physiopathology"[All Fields] OR "dysfunction"[All Fields]) AND ("gait"[MeSH Terms] OR "gait"[All Fields]))) NOT (("neurologic manifestations"[MeSH Terms] OR ("neurologic"[All Fields] AND "manifestations"[All Fields]) OR "neurologic manifestations"[All Fields] OR "neurologic"[All Fields] OR "neurological"[All Fields] OR "neurologically"[All Fields]) AND ("condition s"[All Fields] OR "conditions"[All Fields] OR "disease"[MeSH Terms] OR "disease"[All Fields] OR "condition"[All Fields]))) AND ((humans [Filter]) AND (medline [Filter]) AND (english [Filter])).

Inclusion and exclusion criteria

The development of inclusion and exclusion criteria were based upon the purpose of the present systematic review that is, to determine the availability and efficacy of the current non-surgical treatment modalities to identify studies which have analyzed the effect of non-surgical foot appliances on hallux valgus and on foot function, in general. Studies evaluating operative treatments were excluded. The evaluation of adults was an inclusion criterion, therefore, juvenile assessment of HAV was excluded. The English language and human studies were also inclusion criteria for the literature search. Thus, studies reporting surgical treatment of hallux valgus were excluded. Figure 1 presents the keywords and MeSH headings used. We sought for studies that included the terms in the title or the abstract.

Keywords and MeSH headings used for literature search

Search 1: (((((("hallux valgus"[MeSH Terms] OR ("hallux"[All Fields] AND "valgus"[All Fields]) OR "hallux valgus"[All Fields]) AND ("equipment and supplies"[MeSH Terms] OR ("equipment"[All Fields] AND "supplies"[All Fields]) OR "equipment and supplies"[All Fields] OR ("medical"[All Fields] AND "devices"[All Fields]) OR "medical devices"[All Fields]) AND ("hallux valgus"[MeSH Terms] OR ("hallux"[All Fields] AND "valgus"[All Fields]) OR "hallux valgus"[All Fields])) NOT (("hallux valgus"[MeSH Terms] OR ("hallux"[All Fields] AND "valgus"[All Fields]) OR "hallux valgus"[All Fields]) AND ("surgery"[MeSH Subheading] OR "surgery"[All Fields] OR "surgical procedures, operative"[MeSH Terms] OR ("surgical"[All Fields] AND "procedures"[All Fields] AND "operative"[All Fields]) OR "operative surgical procedures"[All Fields] OR "general surgery"[MeSH Terms] OR ("general"[All Fields] AND "surgery"[All Fields]) OR "general surgery"[All Fields] OR "surgery s"[All Fields] OR "surgerys"[All Fields] OR "surgeries"[All Fields]))) NOT (("dysfunctional"[All Fields] OR "dysfunctionals"[All Fields] OR "dysfunctioning"[All Fields] OR "dysfunctions"[All Fields] OR "physiopathology"[MeSH Subheading] OR "physiopathology"[All Fields] OR "dysfunction"[All Fields]) AND ("gait"[MeSH Terms] OR "gait"[All Fields]))) NOT (("neurologic manifestations"[MeSH Terms] OR ("neurologic"[All Fields] AND "manifestations"[All Fields]) OR "neurologic manifestations"[All Fields] OR "neurologic"[All Fields] OR "neurological"[All Fields] OR "neurologically"[All Fields]) AND ("condition s"[All Fields] OR "conditions"[All Fields] OR "disease"[MeSH Terms] OR "disease"[All Fields] OR "condition"[All Fields]))) AND ((humans[Filter]) AND (medline [Filter]) AND (english [Filter]))

Search 2

("hallux valgus"[MeSH Terms] OR ("hallux"[All Fields] AND "valgus"[All Fields]) OR "hallux valgus"[All Fields]) AND "non-surgical"[All Fields]) AND ((humans [Filter]) AND (medline [Filter]) AND (english [Filter]))

Figure 1

Study eligibility criteria

According to the PRISMA statement [22], prior to literature search we should provide an explicit statement of question regarding participants, interventions, comparisons, outcomes and study design (PICOS). Eligible articles needed to present non-surgical treatment of hallux valgus as well as the progression of the deformity.

Assessment of characteristics of studies

Study selection

The relevance of the study topic was defining for its inclusion in the study, thus we initially assessed titles and abstracts.

Quality assessment

We followed the EPHPP (Effective Public Health Practice Project) [21,23] guidelines in order to assess the quality of each trial and we used the PRISMA flow diagram to report the steps of the search.

Results

The initial search of the database search presented a total of 68 potentially relevant papers searched within the Pub Med. After they were processed 55 articles were excluded while 11 studies fulfilled the inclusion criteria and were included. A study was excluded because it was written in (Korean) [24]. Another reason for the exclusion of two studies was the age of the patients who were juvenile [25,26]. Due to the heterogeneity of the methods used in reporting the availability and efficacy of present non-surgical treatment modalities for the control of the hallux valgus progression and outcome measures, a narrative synthesis of the 8 included studies was performed without meta-analysis.

The PRISMA flow chart and reasons for exclusion are shown in figure 2.

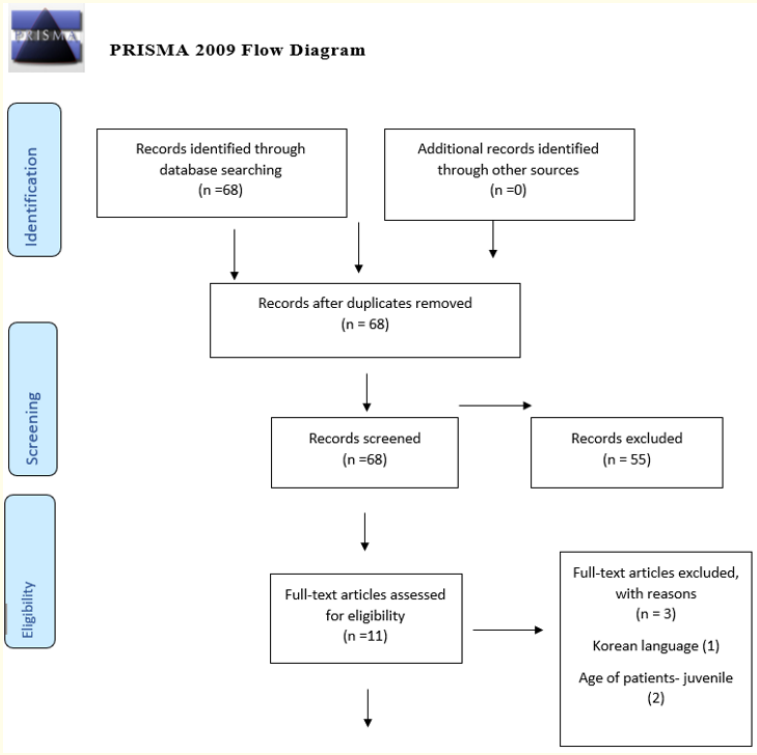

Figure 2: Prisma Flow diagram.

The studies which fulfilled the criteria of this review include Tehraninasr., *et al*. (2008) [27], Chadchavalpanichaya., *et al*. (2016) [28], Abdalbary (2018) [29], Moulodi., *et al*. (2019) [30], Lee and Lee (2016) [31], Tang., *et al*. (2002) [32], Formosa., *et al*. (2017) [33] and Karabicak., *et al*. (2015) [34], as shown in table 1. The studies varied to a great extent in study design, number of participants, the type of conservative treatment as well as reported outcomes. Also, the duration of the included studies and follow-up ranged from four weeks to twelve months. The variability across intervention outcomes in combination with the limited duration of the studies highlight that additional research is needed to extend our understanding and knowledge of how to obtain the desired outcomes.

Reference	Publications	Trial characteristics	Participants	Men	Women	Average age (years)	Follow-up period	Foot Condition	Orthoses	Results measured
[27]	Tehraninasr., *et al*. (2008)	A controlled clinical trial	30	0	30	27 ± 8.91	3 months	HAV	Semi-rigid (insole with toe-separator and night splint)	Pain, foot angles
[28]	Chadchaval-panichaya., *et al*. (2016)	A prospective, randomized single-blinded controlled trial	90	5	85	60.5 ± 10.1	3, 6. 9, 12 months	HAV	Soft (silicone custom-mold toe separator)	Pain, foot angles
[29]	Abdalbary (2018)	A randomized clinical trial	56	0	56	45.6 ± 6.5	12 months	HAV	Toe separator	Pain, foot angles, functional disability
[30]	Moulodi., *et al*. (2019)	A cross-over design study	24	12	12	22.79 ± 1.44	1 month	HAV	Dynamic orthoses, static orthoses	Pain, foot angles, function, quality of life, symptoms
[31]	S.M. Lee J.H. Lee (2016)	A case report	1	0	1	26	3 months	HAV	Kinesiology tape	Pain, foot angles
[32]	Tang., *et al*. (2002)	An uncontrolled intervention study	17	0	17	42.59 ± 16.52	3 months	HAV	Total Contact Insole with fixed toe separator	Pain, foot angles, walking ability
[33]	Formosa., *et al*. (2017)	A time series, quasi-experimental, same-subject design study	35	5	30	44	4 weeks	HAV	Nonelastic zinc oxide taping	Pain, foot function, general foot health, general health, physical activity, social activity, vigor
[34]	Karabicak., *et al*. (2015)	Interrupted time series	21	0	21	43.1 ± 12.4	1 month	HAV	Kinesiotaping	Pain, foot angles, functional status

Table 1: Main characteristics of the studies included.

The study of Tehraninasr., *et al.* (2008) [27] was a controlled clinical trial and compared the effects of semi-rigid foot orthoses, i.e., a night splint and an insole with toe separator in patients presenting mainly mild to moderate HAV. Thirty subjects were divided into two groups the first of which used the insole and toe separator and the second group the night splint. After a 3-month study period the deformity slightly decreased in both groups. However, the orthosis group showed greater improvement as far as pain intensity is concerned, mainly because of the restoration of correct anatomic alignment of foot it provided. It was noted that the three-month-follow-up appeared to be rather short for structural changes to occur, however increase in angulations that lead to HAV progression was prevented. The combination of the above along with the small sample of subjects render this study as rather low in rigor.

The study of Chadchavalpanichaya., *et al*. (2016) [28] was a prospective, randomized single-blinded controlled trial and examined the effectiveness of the use of a soft custom-mold room temperature vulcanizing silicone toe separator in order to reduce foot pain caused by hallux valgus deformity. The compliances, complications, and satisfactions of toe separator were also defined. The participants were 90 patients with a moderate degree of hallux valgus

and they were randomly allocated into two groups. Radiographic measurement was used to determine hallux valgus angle and there was a follow-up at month 12. It was shown that both groups had substantial differences in mean hallux valgus angle: the study group presented a decrease of 3.3° ± 2.4° and the control group an increase of 1.9° ± 1.9°. Furthermore, at the end of the study the hallux valgus angle presented differences between the two groups ($p < 0.05$). However, Chadchavalpanichaya., *et al*. (2016) [28] reported that the intervention was effective only in the case of proper footwear. Furthermore, in PP treatment, tests for statistical analysis were performed solely on participants who completed the full treatment. These characteristics decrease the reliability of the study results.

The study of Abdalbany., *et al.* (2018) [29] was a randomized clinical trial that worked on to determine the effects of foot joint mobilization combined with exercise, and the use of a toe separator on symptomatic moderate hallux valgus in female patients. 56 women with moderate hallux valgus were randomly allocated for 36 sessions for 3 months or no intervention. The treatment for patients in the treatment group included foot joint mobilization, strengthening exercises for hallux plantarflexion and abduction, toe grip strength, stretching for ankle dorsiflexion, as well as the use of a toe separator. Abdalbary (2018) [29] concluded that there was greater improvement in all measurements for patients who were treated with 3 months of foot mobilization and exercise along with a toe separator, while than those who did not receive an intervention experienced less improvement in outcome measures. The follow-up was at month 12 according to which the improvement in pain and the other measurements were reported. These results support that moderate hallux valgus should be treated with the use of a multifaceted conservative intervention, although more research is needed to define the effectiveness of the several aspects of the intervention. It is important to note that patients involved in the study reported no further pain during the treatment period. Furthermore, the randomization and blinding of the study as well as its overall conduct render it as quite high in rigor.

The Moulodi., *et al*. study (2019) [30] was a cross-over study the aim of which was to compare the hallux valgus angle, hallux valgus range of motion, and patient satisfaction through the use of static and dynamic orthoses. Twenty-four participants presenting with mild to moderate HAV were involved in this study, twelve men and twelve women. They were randomly allocated to orthotic treatments at the start of the study and following switched orthoses. The measurements showed that the hallux valgus angle can be reduced up to 2-3° by using both static and dynamic orthoses for 1 month with the suggestion of a longer period of use for better results. However, there were no radiographic measurements and the sample of patients involved was rather small. Moreover, the patients reported that they felt both orthoses twisting on their feet, particularly on the second toe with the static orthosis.

Lee and Lee, (2016) [31] was a case report study presenting with moderate hallux valgus; the aim of the study was to determine the effects of repeated balance taping with the use of elastic tape on hallux valgus. A 26-year-old woman with bilateral moderate hallux valgus experienced pain over the medial eminence of the hallux metatarsophalangeal (MTP) joint during walking. The treatment period was 3 months and the patient experienced decrease in pain while walking long distances in shoes. The measurements presented reduction on both hallux valgus angles. Lee and Lee (2016) [31] suggested that moderate hallux valgus could be complementarily treated with repeated balance taping along with kinesiology tape; however, it was a case report and, for this reason, the results cannot be applied to the general population. The conduct of further research is essential in order to determine whether taping can be effective for patients with more severe symptoms, along with comparative studies with other conservative therapies.

Tang., *et al*. (2002) [32] was an uncontrolled intervention study, which identified the effects of a new foot-toe orthosis (a new total contact insole with fixed toe separator) on painful hallux valgus. Seventeen women with painful hallux valgus participated in the study. Only 12 patients completed the follow-up at three months; however, all patients showed no clinical evidence of blister formation or skin ulcers during the treatment period. The outcome measurements showed hallux valgus angle reduction as well as great pain reduction. Tang., *et al*. (2002) [32] stated that the new total contact insole with fixed toe separator reduced pain, and improved walking ability as well as the hallux valgus angle. However, the sample of patients involved in the study was rather limited and even less was the total amount of patients who completed the study.

Formosa., *et al*. (2017) [33] conducted a time series, quasi-experimental, same-subject design study, the aim of which was to

determine the effect of a taping technique on the quality of life in patients presenting with hallux abducto valgus deformity. Thirty women and five men were the participants of the study and a non-elastic zinc oxide tape was applied for 4 weeks (10 hours/per day). The assessment of the participants' quality of life was conducted using the Foot Health Status Questionnaire before and after the intervention. According to the outcome of the measurements, there was reduction in foot pain, foot function, and general foot health (P .0001). Formosa., *et al*. (2017) [33] reported improvement in managing hallux abducto valgus and better quality of life; however, further study is needed to evaluate larger sample groups and longer treatment periods probably in combination with exercise and/or orthoses.

Karabicak., *et al*. (2015) [34] study was an interrupted time series study, the purpose of which was the assessment of short-term effects of kinesiotaping on pain and joint alignment as an alternative, conservative treatment of hallux valgus. The participants were twenty-one female patients, who were treated with the use of kinesiotaping. The results measured were pain, foot angles (hallux adduction angles, measured by goniometry), patients' functional status (measured by AOFAS) and finally the radiographic results, measured before and after 1 month of treatment. According to the study, there was a significant difference in pain intensity (P = .001), hallux valgus angle (P = .001) as well as radiographic results in1-month control (P.009). Pain and disability in hallux valgus deformity were reduced. It has to be reported that the sample was rather small, which has an effect on the study rigor despite the positive results.

The following discussion provides further observations on review findings.

Discussion

The aim of this systematic review was to determine the availability and efficacy of the current non-surgical treatment modalities and to perform a systematic literature search to identify studies which have analyzed the effect of non-surgical foot appliances on hallux valgus, the effect of hallux valgus appliances on foot function, including muscle action, 1st ray biomechanics, hallux valgus angle and plantar pressure distribution, the effect of hallux valgus applications on pain, deformity and disability and to perform a quality assessment to identify the rigor of the identified studies. This objective arose from the fact that Hallux Abducto Valgus is the most frequent and common, multifactorial, painful foot condition associated with a deformation of the big toe. Dysfunctions in the biomechanics of the first ray such as hypomobility or hypermobility have been suggested to play a key role in several foot conditions. The insufficient number of studies found about this topic in the literature, was the reason for the proposal of a systematic review in order to collect as much information as possible regarding this foot condition. Eight studies were included in the review for analysis, a rather limited number of studies, which is one limitation of this study. The EPHPP (Effective Public Health Practice Project) quality assessment tool for quantitative studies was applied according to which the assessment and presentation of individual domains was recommended. Among other domains, the rating components regarded selection bias, study design, confounders, blinding, data collection methods and withdrawals and drop-outs. Each component was recommended to be rated as strong, moderate or weak depending on certain criteria considered, as stated in detail in the Dictionary of the EPHPP Quality Assessment Tool for Quantitative Studies [35]. The purpose of the dictionary, according to its guidelines, was to assist raters to assess study quality and in order for this to be achieved raters should be aware that their opinion should be based upon information contained in the study rather than inferencing about the authors' intentions.

As far as the component of selection bias is concerned, randomization of the selected participants and the percentage of the subjects that agreed to participate in the study before being assigned to intervention or control groups is significant for the assessment of the study quality. Of the eight studies reviewed only in two it is explicitly stated that the subjects' consent was obtained prior to study participation; in four it is mentioned that subjects gave their consent and in two it is not mentioned at all (one of the studies is a case report). It is noteworthy that participants in the studies included were recruited from universities in Asia (Iran, Thailand, Taiwan, Republic of Korea, Turkey), a university from Africa (Egypt) and only one from a European western university (Malta) using convenience sampling procedures.

According to EPHPP quality assessment ratings the methodological quality of the studies included in this review were rated as follows: three of the studies were rated as weak, three as moderate and only two as strong. The main weaknesses identified included

not blinding assessors and participants to group allocation, lack of representative sampling as well as low number of participants with mean participants number of 39 (rating from 21 to 90, the case report is excluded). Addressing these issues should be the aim of future research in order to improve the methodological quality of the evidence for conservative treatment of hallux abducto valgus.

The design of four of the studies included in this review was rated as strong, three were rated as moderate and one as weak; however, blinding of outcome assessors and participants was not reported by most of the studies. Consequently, it is most probable that detection and reporting bias [36] affected the outcomes of these studies. It is noteworthy that none of the studies involved in this review were double-blinding; therefore, they could not be rated as strong as far as the blinding domain is concerned, mainly because it was not mentioned whether study participants were aware or not of the research question.

Lastly, taking into consideration the fact that intervention durations varied to a great extent across studies (4 weeks-12 months), which has a significant effect on both the reliability of their findings and the ability to compare study outcomes as well as the lack of representative sampling, it is evident that future research should aim at longer-term studies extending to two or more years, which might be more representative and present more reliable and veracious findings.

Reference	Publications	Selection BIAS	Study design	Confounders	Blinding	Data collection methods	Withdrawals and drop-outs	Global rating
[27]	Tehraninasr., *et al.* (2008)	2	1	3	2	1	3	3
[28]	Chadchavalpanichaya., *et al*. (2016)	2	1	3	2	1	1	2
[29]	Abdalbary (2018)	2	1	1	2	1	1	1
[30]	Moulodi., *et al*. (2019)	2	3	1	2	3	1	3
[31]	S.M. Lee, J.H. Lee (2016)	3	2	3	2	1	N/A	3
[32]	Tang., *et al*. (2002)	2	2	3	2	1	2	2
[33]	Formosa., *et al.* (2017)	2	1	2	2	1	1	1
[34]	Karabica., *et al.* (2015)	2	2	3	2	1	1	2

Table 2: Effective Public Health Practice Project quality assessment results.

1: strong, 2: moderate, 3: weak, N/A: Not Applicable

Limitations

A number of limitations are identified, some of which might as well present opportunities for future research. First, the parameters used for search were in line with the present review's research aim, thus the number of studies identified was limited to that purpose. In particular, studies published in languages other than English and grey literature were excluded. Future research may include these domains of literature and research. Further, in the present review, due to the small number of included studies, there is high degree of heterogeneity in study design features and clinical methods, which rendered it impossible to conduct meta-analysis. Thirdly, even though the EPHPP quality assessment tool, as one of numerous quality assessment tools available, was considered appropriate for the present review, it should be noted that quality ratings should be

performed having in mind the specific characteristics and features of this tool as well as the fact that different tools perform differently and might lead to different evaluation outcomes [23]. Finally, it is not always achievable or realistic to obtain representative samples for a study as well as blinding in various interventions. Quality assessment tools such as the one used in the present review, have certain features, therefore, interpretation of results should be cautious and take into consideration the specific characteristics of the EPHPP. The crucial domains that determine the rigor and validity of a study are representative samples, study design, blinding and retention rates. Therefore, research should investigate and determine their applicability within different research designs.

Conclusions

The scarcity of high-quality evidence in literature regarding non-operative treatment of HAV intensifies the fact that the conduct of further studies is needed in order to provide rigorous results and knowledge on the conservative treatment of such a common and painful deformity. Therefore, future studies should aim towards the improvement of the methodological quality of evidence in combination with the investigation of the most appropriate non-operative treatments as well as prevention of HAV progression, especially in early stages of the deformity in order to achieve the desired outcome.

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All of the participants who consented to participate in this study.

Authors' Contributions

Emmanouil Arvanitakis: Conceptualization, Methodology, Investigation, Writing- Original draft preparation and Editing. *Cynthia Formosa* and *Alfred Gatt*: Supervision, Validation and Reviewing.

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Ethics Approval and Consent to Participate

Not applicable.

Consent for Publication

Not applicable.

Conflict of Interest Statement

None.

Declaration of Interest

None.

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