

A Review of the Efficacy of Different Types of Orthoses on Hallux Valgus Angle and Pain Among the People with Hallux Valgus Deformity

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ABSTRACT

Background: Hallux valgus is a lateral deviation of the great toe, which results in a bony prominence at the MTP joint. It is one of the most prevalent diagnoses affecting up to 23% of women, aged 18 to 65 and around 35% of women over 65 years of age are at risk of developing hallux valgus. It appears that hallux valgus is multifactorial etiology and not yet completely investigated ⁽¹⁾. Hallux valgus has been linked with severe toe pain, impaired foot function, difficulty in fitting footwear, and decreased quality of life due to health issues. Several complicated and multifaceted variables can contribute to Hallux valgus, including wearing inappropriate footwear, abnormalities in the anatomy and mechanics of the foot, limb inequality, work-related risks, inflammatory joint disease, and genetics. ⁽⁴⁾ Due to the first metatarsal & lateral deviation in hallux valgus, the first metatarsophalangeal joint gradually subluxes. Hallux lateral deviation increases hallux valgus angle leading to the rotation of the metatarsals and the metatarsophalangeal joint to experience valgus torque, which pulls the hallux away from its articular surface resulting in pain. ⁽²⁾ For first-line treatment, various conservative options have been suggested, including various kinds of orthoses, splints, and physical therapy. ⁽¹⁾

Objective: The objective of this literature review is to assess the effect of splinting on hallux valgus angle and pain among the individual with hallux valgus deformity.

Study design: Literature Review

Significance: The review was done to investigate the effect of splints or orthoses on hallux valgus angle and associated pain among the individuals with hallux valgus deformity because hallux valgus angle and pain are the main primary factor which are affected in this condition. Thereby reviewing the literature on the hallux valgus angle and pain will provide a clear protocol so that the application of splinting can be incorporated in a more efficient manner.

Method: An electronic database search was conducted using google scholar, science direct, PubMed, Cochrane library and reference list from all the retrieved articles.

Results & discussion: A total 36 research papers were quality rated. After exclusion of the studies without reported measurement reliability for associated factor for hallux valgus angle and pain, data were extracted and analyzed from 15 studies. It was found from the review of data that there was significant improvement in pain after using orthosis. About 8 studies stated significant improvement in hallux valgus angle after the use of orthoses in which type of orthosis used were 3D printed orthosis, toe separator with insole, static & dynamic splints, designed slippers with toe separator and hallufix splint. Whereas one study showed that splint can decrease subjective deterioration of the greater toe in hallux valgus deformity with the use of dynamic splint. Out of 15 studies, 5 studies clearly state that orthosis had no effect on hallux valgus angle.

Conclusion: There is significant correlation between the reduction of the hallux valgus angle and pain intensity after using orthoses for hallux valgus. Toe separator and dynamic orthosis have better outcome results as compared to various other orthoses used for hallux valgus in improving the hallux valgus angle and pain. Thereby orthosis plays an important role as a conservative management by preserving the great toe's anatomical alignment in hallux valgus deformity.

Keywords: hallux valgus, hallux valgus angle, splint, orthoses, pain

INTRODUCTION

Hallux valgus (HV) is characterized by the lateral displacement of the great toe which leads to painful bony prominence of the first metatarsal head. ⁽⁵⁾ The most prevalent foot disorders having a biomechanical etiology is hallux valgus. ⁽²⁾ In addition to affecting foot appearance, hallux valgus also results in functional limitation, such as foot pain, altered gait patterns, and balance issues, all of which increase the risk of falling and leads to poor quality of life. ⁽³⁾ An estimated 23% of individuals and 37.5% of older people have hallux valgus, a common foot deformity. ⁽⁶⁾ The prevalence of radiologic hallux valgus is more in women aged between 18-65 years and & 35% in women older than 65 years. ⁽¹⁾ Multiple conservative treatment approaches, such as orthoses, splints, and different types of physiotherapy, have been recommended as the initial course of treatment. ⁽¹⁾ When the HV angle is mild (30°), patients typically get conservative therapies such night splints, foot exercises, and the use of orthotics. However, prior research indicated that for patients with mild-to-moderate HV, the effectiveness of orthotic devices and night splints were no better than no treatment at all. Recent research has examined the efficacy of conservative measures such the use of fixed toe separator foot insoles. ⁽³⁾ Extreme cases of hallux valgus require surgical intervention but the recurrence rate is high and surgery may reduce the subsequent mobility of big toe hence making non-surgical conservative

treatments like foot orthoses popular option. ⁽⁶⁾ But there is some disagreement around conservative treatments, like the orthoses, even though numerous studies have demonstrated their efficacy. ⁽⁵⁾ Foot orthoses are useful in preventing hallux valgus, according to certain long-term research, however other studies dispute this, resulting in a need to find the effectiveness of orthoses for the treatment of one of the most common foot disorders like hallux valgus. The different types of orthoses which were used were static, dynamic, 3D printed, toe-separator with insoles.

MATERIALS & METHODS

Various articles from following databases like Google scholar, Science Direct, PubMed and Cochrane library were retrieved through a search by using keywords- hallux valgus deformity, hallux valgus angle, splint, orthoses, pain, etc. Studies which include hallux valgus angle and pain as a parameter for the evaluation of the effect of splinting or orthoses on hallux valgus deformity were included in the study. Total 15 articles were included in the study and based on their findings a review was made.

RESULT

Total 15 articles were taken and studied. Out of which three were literature reviews and twelve were experimental studies. The details of the reviewed articles are tabulated in given table.

S.no	Authors	Title	Type of orthoses	Conclusion
1.	Guoli Li, Jinsong Shen, Edward Smith 2 and Chetna Patel 2022	The Evaluation of Orthotics in Reducing Hallux Valgus Angle in Patients with Hallux Valgus over	<ul style="list-style-type: none"> • Dynamic orthoses • Static orthoses • Toe separator(silicone) 	There was a continuous decrease throughout the course of the 12-month therapy period after using dynamic orthosis. For patients with moderate Hallux Valgus, the dynamic orthosis proved effective

		a Twelve-Month Treatment		in lowering the Hallux valgus angle. After a year of therapy, static orthosis also decreased the hallux valgus angle for patients with mild and moderate hallux valgus deformity.
2.	Bahar Anaforoglu Kulunkoglu, Yasemin Akkubak, Derya Celik, Afra Alkan 2021	A comparison of the effectiveness of splinting, exercise and electrotherapy in women patients with hallux valgus: A randomized clinical trial	<ul style="list-style-type: none"> • Static orthoses 	Showed that the splinting and exercise groups experienced greater decrease in hallux valgus angles than the electrotherapy group. Electrotherapy may be a good option for enhancing the therapeutic benefits, and that splinting and exercise have long-acting effects for treating HV symptoms. With extended follow-up periods, a combination of these conservative therapy modalities may be more advantageous for managing HV symptoms.
3.	Mei-Ying Kwan, Kit-Lun Yick, Joanne Yip, Chi-Yung Tse 2021	The immediate effect of hallux valgus orthoses: a comparison of orthosis design	<ul style="list-style-type: none"> • Static orthoses • Flexible orthoses 	The correction of the hallux valgus angle is statistically significant when the subjects with hallux valgus use the orthoses.
4.	Mei-Ying Kwan, Kit-Lun Yick, Joanne Yip, Chi-Yung Tse 2021	Hallux valgus orthosis characteristics and effectiveness: a systematic review with meta-analysis	<ul style="list-style-type: none"> • Different kind of orthoses has been included (design is not specified) 	Showed the positive relationship between hallux valgus angle and pain reduction level after using orthoses with toe separator.
5.	Pi-Chang Sun, Shih-Liang Shih, You-Yu Chen, Kuang-Wei Lin and Chen-Shen Chen 2021	Evaluation of Patients with Hallux Valgus Wearing a 3D-Printed Orthosis during Walking	<ul style="list-style-type: none"> • 3D printed static orthoses 	Study used 3D printing to create a novel soft hallux orthosis that has reduce the hallux valgus angle by 10.9 degrees in standing position and 9.3 degrees while walking.
6.	Sheree E. Hurn, Barry G. Matthews, Shannon E. Munteanu, Hylton B. Menz (2020)	Effectiveness of non-surgical interventions for hallux valgus: a systematic review and meta-analysis	<ul style="list-style-type: none"> • Foot orthoses • Night(static) splint • Dynamic orthosis 	The majority of effect estimates are 'very low' to 'low' in certainty, although there is moderate certainty that foot orthoses may lessen pain in the intermediate term and moderate certainty that pain and HV angle may improve with Botox injections.
7.	Christian Plaassa, Annika Karchb, Armin Kochb, Vivien Wiederhoefta, Sarah Ettingera, Leif Claassena, Kiriakos Daniilidisa,c, Daiwei Yaoa, Christina Stukenborg-Colsman (2019)	Short term results of dynamic splinting for hallux valgus — A prospective randomized study	<ul style="list-style-type: none"> • Dynamic orthoses 	Found dynamic splinting effectiveness on reducing pain and delaying subjective deterioration of the toe position and enhances patient's satisfaction.
8.	Nasrin Moulodi, Mojtaba Kamyab, Maede Farzadi (2019)	A comparison of the hallux valgus angle, range of motion, and patient satisfaction after use of dynamic and static orthoses	<ul style="list-style-type: none"> • Static orthosis • Dynamic orthosis 	Showed decrease in hallux valgus angle up to 2-3 degrees with the use of static and dynamic orthoses and passive range of motion of the first metatarsophalangeal joint has also increased after 1-month intervention.
9.	Ryosuke Nakagawa, Satoshi Yamaguchi, Seiji Kimura, Aya Sadamasu, Yohei Yamamoto, Yuta Muramatsu, Yasunori Sato, Ryuichiro Akagi, Takahisa Sasho, Seiji Ohtori (2019)	Efficacy of foot orthoses as non-operative treatment for hallux valgus: A 2-year follow-up study	<ul style="list-style-type: none"> • Insole 	Individuals with hallux valgus deformity found non-operative treatment as a more comfortable option for reduction of pain after using foot orthoses.
10.	Navaporn Chadchavalpanichaya, Voraluck Prakotmongkol, Nattapong Polhan, Pitchaya Rayothee and Sirirat Seng-Iad (2017)	Effectiveness of the custom-mold room temperature vulcanizing silicone toe separator on hallux valgus: A prospective,	<ul style="list-style-type: none"> • Silicone toe separator 	With no significant side effects, a custom-molded room-temperature vulcanizing silicone toe separator could reduce hallux valgus angle and pain.

		randomized single-blinded controlled trial		
11.	John Tzu-Ning Chen, Chih-Kuang Chen, Alice Chu-Wen Tang, Simon Fuk-Tan Tang (2016)	Effective Conservative Treatment for Managing Painful Hallux Valgus	<ul style="list-style-type: none"> Insole with toe separator 	Reflected that hallux valgus could be successfully treated with the application of an insole with a fixed toe separator and Botulinum toxin type A injection.
12.	María Reina, Guillermo Lafuente and Pedro V Munuera (2012)	Effect of custom-made foot orthoses in female hallux valgus after one-year follow up	<ul style="list-style-type: none"> Custom made insole 	Found that custom made foot orthotics had no effect in the evolution of mild and moderate HV in the women over a 12 month period.
13.	Babak Mirzashahi , Mahdieh Ahmadifar , Mehdi Birjandi , and Yadollah Pournia (2011)	Comparison of Designed Slippers Splints with the Splints Available on the Market in the Treatment of Hallux Valgus	<ul style="list-style-type: none"> Design slipper Toe separator 	There is a decrease in hallux valgus angle in the foot among patients who has used the customized/designed splints. In addition, a significant difference was found concerning the decrease in the angle between the first and second metatarsals in the left and right feet at the end of the study, therefore use of the designed/customized splints resulted in considerable corrections of hallux valgus in the case group.
14.	Ali tehraninasr, hassan saees, bijan forogh, Mahmood rahramizadeh, mohammad reza keyhani (2008)	Effects of insole with toe-separator and night splint on patients with painful hallux valgus: A comparative study	<ul style="list-style-type: none"> Insole + toe separator Static splint 	Found that insole with toe separator as an effective orthotic treatment than night splints for patients with painful hallux valgus deformity in reducing pain. Hallux valgus angle and intermetatarsal angle neither increase or decrease after the use of both the orthoses.
15.	Simon f. tang, carl p. chen, jen-li pan, jean-lon chen, chau-peng leong, ngok-kiu chu (2002)	The effects of a new foot-toe orthosis in treating painful hallux valgus	<ul style="list-style-type: none"> Toe separator with arch support 	Found the new foot-toe orthosis helpful to reduce hallux valgus angle, pain and it also improve the walking ability of the person with hallux valgus deformity.

DISCUSSION

The non-operative management of hallux valgus is a topic of significant debate. While some advocate for splint use, others believe that splints are worthless when used as a non-operative treatment. ⁽¹⁶⁾ There are significant obstacles in the non-operative treatment of patients with hallux valgus because of the paucity of studies that support the usefulness of splints.⁹ This study analyses the attributes of hallux valgus orthoses and their impact on hallux valgus angle and pain by meticulously analyzing and synthesizing data from a substantial amount of literature.

Orthoses

In hallux valgus deformity, orthoses hold the hallux in abduction in order to provide and maintain a correct position to the great toe. It also helpful to relieve pain,

discomfort, plantar pressure over the first metatarsophalangeal joint, and other associated factors of the deformity.

There is different type of orthoses which can be prescribed in hallux valgus deformity. Such as, static orthosis, dynamic orthoses, toe separator, toe separator with insole, insole, 3D printed design, and other different kind of prefabricated orthoses.

Hallux valgus (HV) angle

The HV angle lies between the longitudinal axis of the proximal phalanx and the first metatarsal bone of the hallux. An angle of $>15^\circ$ indicates hallux valgus deformity. A common grading scale (Manchester scale) of hallux valgus in consideration of the first metatarsophalangeal angle is normal: $<15^\circ$, mild: $15-25^\circ$, moderate: $25-35^\circ$, severe: $35-45^\circ$.

Hence, the aim of the study is to review and evaluate the effectiveness of orthoses on hallux valgus angle and pain for hallux valgus deformity. After thorough review of literature and screening as per the inclusion criteria of the present study, we obtained data from 15 research articles.

It has been noted that hallux valgus deformity impairs foot mechanics, such as hallux valgus angle, pain, foot function, static & dynamic balance, range of motion of the first metatarsal joint, increase in plantar pressure, and poor appearance of the foot, etc. causing problems with lower extremity alignment and foot biomechanics. Thus, gait parameters are negatively affected due to pain and walking deviations. In such condition foot orthoses are believed to reduce the medial pressures that produce the hallux valgus deformity and symptoms associated with it.⁸ Orthoses have been used to reduce the factors that are disturbed by the foot condition. In case of hallux valgus deformity studies suggest that after using static and dynamic orthoses, orthoses helps to reduce the hallux valgus angle by approximately 2-3° among patients with HV after one-month intervention. (2) Results of comparative study between splinting, exercise and electrotherapy revealed that splinting exhibits much better results to improve hallux valgus angle as compared with exercise and electrotherapy. (8) Studies also show the importance of dynamic splint in reducing pain and its role in delaying subjective deterioration of the great toe in hallux valgus deformity. (1) Customized orthosis found better results than prefabricated in terms of correction of hallux valgus angle and patients' satisfaction. (13) After the regress analysis of the studies we observed that in the articles, there is no statement about the follow-up of the participants and how the researcher has confirmed that the whether the participant are using the orthoses or not and in few studies intervention period provided with the splint is also too long (around 1-2 year) with zero to minimal follow up thereby making any claim about the effects of

orthosis would be a matter of question. Due to the different intervention period the results and conclusion are also varying from one study to another study. Thereby we found that around eight research studies claim that orthoses can help to minimize the Hallux valgus angle and correct great toe alignment along maximum studies found reduction in pain associated with the hallux valgus.

CONCLUSION

This comprehensive study shows a correlation between the reduction of the hallux valgus angle and pain intensity after the use of different type of orthoses including 3D printed orthosis, static orthosis, dynamic orthosis, toe separator, designed slippers and arch support. Therefore, it is crucial to incorporate orthoses as an essential element as the non-surgical management hallux valgus deformity. After intense review of literature, it is evident that for hallux valgus deformity a toe separator or a dynamic orthosis has better outcome results in improving hallux valgus angle and in reducing pain in order to preserve the great toe's anatomic alignment. The findings of this study give patients, practitioners, and doctors crucial information that will aid in their decision-making regarding the best course of treatment for hallux valgus deformity which might serve as a better prescription protocol for the patients in assisting them to better understand the benefits and effectiveness of using the orthoses.

Limitation

- Treatment protocol and specified prescription, guidelines are indefinite due to less reliable evidence.
- Many review studies on orthoses have not defined the type of orthosis used as intervention therefore it is difficult to suggest which type of orthosis is best suited for hallux valgus deformity.

Future Aspects

- More regress review of literature and meta-analysis should be done to standardize a perfect orthosis which can be most beneficial for the treatment of hallux valgus and thereafter its effects can be evaluated on various parameters like stride parameters, hallux valgus angle, pain etc.
- Studies should include the regular follow-up and how they are ensuring that whether the participants are using the orthoses or not should also be documented in order to get authentic research data.
- More research studies can be done on designing of splint, type of splint, material used to fabricate splint so as to improve the treatment protocols for hallux valgus patients.
- Studies can be done on gender differences as prevalence of RA in females is three times higher than males and nature of tasks performed by both the gender varies hugely.

Declaration by Authors

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