



**FACULTY OF HEALTH SCIENCE
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THE EFFECT OF PHYSIOTHERAPY IN HALLUX VALGUS TREATMENT

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SUMMARY

Laurynas Pielikis “The effect of physiotherapy in Hallux Valgus Treatment”, Physiotherapy study programme, Faculty of Health Sciences, Klaipeda State University of Applied Sciences, Klaipėda.

Problem. The lack of physiotherapy treatments analysis for patients with hallux valgus in order to reduce angle and improve balance and gait patterns.

Object. different methods of physiotherapy applied for patients with hallux valgus.

Aim. To analyze the effect of physiotherapy for hallux valgus.

Methods of research. Systematic literature analysis.

Results. Physiotherapy’s methods for hallux valgus treatment are found to be effective and can significantly reduce the HV angle, especially, when kinesio taping is applied together with joint mobilization. The methods applied in order to improve gait patterns and balance didn’t show significant results, however, the combination of kinesio tape and stretching improved the body balance ability.

Conclusions.

1. Hallux valgus condition is more frequent in women, tends to increase with age, turning the elderly women into the most common patients with hallux valgus;
2. Kinesio taping was found out to be the most effective method in the hallux valgus angle reduction;
3. The combinations of a kinesio tape and exercising methods (joint mobilization or stretching) showed better results than in those studies groups where only one treatment method has been applied.
4. The physiotherapy treatments applied for hallux valgus angle reduction show greater results and offer a wider variety of studies proving the efficiency, compared to the studies for gait pattern and balance.

Keywords. Hallux valgus, hallux valgus angle, gait patterns and balance, physiotherapy methods of treatment, conservative treatment, exercise, taping, stretching.

SANTRAUKA

Laurynas Pielikis “Kineziterapijos poveikis esant hallux valgus deformacijai”, Kineziterapijos studijų programa, Sveikatos mokslų fakultetas, Klaipėdos Valstybinė kolegija, Klaipėda, 2020.

Problema. Kineziterapijos gydymo analizių trūkumas pacientams su hallux valgus deformacija ir jų poveikis hallux valgus kampo mažinimui bei balanso bei stovėsenos gerinimui.

Darbo objektas. Skirtingi kineziterapijos gydymo metodai taikomi pacientams su hallux valgus deformacija.

Tikslas. Išanalizuoti kineziterapijos poveikį hallux valgus gydymui.

Metodas. Sisteminė literatūros analizė.

Rezultatai. Kineziterapijos metodai taikomi hallux valgus gydymui yra efektyvūs ir gali ženkliai sumažinti hallux valgus kampą, tais atvejais, kai taikomas kinezioiteipas kartu su sąnarių mobilizacijos pratimu. Metodai taikomi balanso bei stovėsenos pagerinimui neparodė tokių gerų rezultatų, visgi, kinezioiteipas ir tempimo pratimai pagerino pacientų balanso galimybes.

Apibendrinimas.

1. Hallux valgus deformacija yra ženkliai labiau paplitusi moterų tarpe ir progresuoja su amžiumi - vyresnės moterys dažniau skundžiasi HV deformacija;
2. Kinezioiteipas yra vienas efektyviausių būdų mažinti hallux valgus kampą.
3. Kinezioiteipo ir kineziterapijos pratimų kombinavimas (sąnarių mobilizacija ir tempimo pratimai) rodo geresnius gydymo rezultatus nei tose grupėse, kuriose buvo taikomas vienas gydymo metodas.
4. Kineziterapijos gydymo būdai taikyti hallux valgus kampo mažinimui parodė geresnius rezultatus ir turi platesnį publikuotų tyrimų spektrą nei metodai taikyti balansui ir stovėsenai.

Raktiniai žodžiai. Hallux valgus, hallux valgus kampas, stovėsenos ir balansas, kineziterapijos gydymo metodai, konservatyvus gydymas, pratimai, kinezioiteipas, teipingas, tempimo pratimai.

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Abbreviations

Nr. – Number;

HV - Hallux valgus;

HVA - Hallux valgus;

MTP - The first phalangeal joint (metatarsophalangeal);

IMA - Intermetatarsal angle;

MTT – Metatarsal;

KT - Kinesio tape;

KTJM - Kinesio tape joint mobilization;

TSO - Toe-spread-out.

INTRODUCTION

Valgus deformation of the first toe is one of the most common pathologies in humans. It occurs in approximately 23% of adults aged 18 to 65 years and up 36% of adults older than 65 years old. When looking at adult females, HV deformity occurs as high as 30% (Kuhn, et al., 2020). A number of factors have been identified that create a predisposition for the development of hallux valgus, including female age, gender, constricting footwear, and even genetics (Friedmann, et al., 2019).

In general, Hallux Valgus is diagnosed by measuring the angles: the angle between the first metatarsal and the hallux and the angle between the first and second metatarsals, and the distal metatarsal articular angle. While a normal HV angle (HVA) is $\leq 15^\circ$, and the first to second intermetatarsal angle is $\leq 8^\circ$ - 9° (Minkyung, et al., 2020). Clinically, Hallux Valgus is classified into three types, mild (20° - 30°), moderate (30° - 40°) and severe ($>40^\circ$) (Hallux Valgus Market Insight, Epidemiology and Market Forecast - 2030, 2020).

HV deformity presents with a chronic progressive onset. The proximal phalanx pronates and deviates laterally while the first metatarsal head deviates medially, becoming painful and red. Patients typically present with a chronic onset of sharp or deep pain at the MTP joint and also complain about an aching pain at the head of the second metatarsal. As Hallux Valgus progresses, the duration, frequency and severity of the pain eventually increase. Another common presentation is burning pain, tingling at the dorsal part of the deformity. These symptoms may limit physical activities of patients (Kuhn, et al., 2020).

The therapy choices for Hallux Valgus comprises self-care, pain-relieving medications, medical devices, non-surgical treatment and finally a surgery. The kind of treatment suggested to the patient depends upon the severity of the condition (Hallux Valgus Market Insight, Epidemiology and Market Forecast - 2030, 2020).

The problem of the research is the lack of physiotherapy treatments analysis for patients with hallux valgus in order to reduce angle and improve balance and gait patterns.

The object of my research: different methods of physiotherapy applied for patients with hallux valgus.

The aim: to analyze the effect of physiotherapy for hallux valgus.

The tasks of the research are:

1. To analyze literature about causes, symptoms, and stages of hallux valgus;
2. To analyze the effects of different methods of physiotherapy applied for patients with hallux valgus in order to improve gait patterns and balance;
3. To analyze the effects of different methods of physiotherapy applied for patients with hallux valgus in order to reduce the angle of hallux valgus;

The methods of research: systematic literature analysis.

THEORETICAL PART

1. HALLUX VALGUS: RECOGNITION & DEVELOPMENT

Hallux valgus is one of the most usual malformations of the human foot. It causes pain, walking difficulties and can even be problematic for choosing the proper footwear. According to the definition it is described as a lateral deviation of the great toe at the metatarsophalangeal joint (Hyun, et al., 2019). Hallux valgus (abduct valgus), an irreversible foot deformity, is defined in the International Classification of Disease (ICD-10, M20.1) as an acquired deformity of toes (a big toe) (ICD., 2020). Another term, a bunion, which is often used to describe the same condition, describes the enlargement and chronic swelling of the medial projected eminence. The condition leads to disruption of the first metatarsophalangeal joint alignment. Eventually, patients would complain of pain, while in severe cases, joint dislocation, impaired gait, poor balance and fall could happen (Abhishek, et al., 2010). Patients with hallux valgus are having a negative impact on the quality of life in terms of pain and functions (Lazarides, et al., 2005).

Prior to 1870, the deformity of the great toe was referred to as a mentioned “bunion,” a term that means a “bump” or “tumor.” Clearly, that mischaracterization was a failure to understand the malalignment of the hallux. Carl Heuter, German surgeon, is most often credited with originating the term hallux valgus, moving the medical apprehension forward in accepting that the hallux has drifted laterally. The term "valgus deformation" was first introduced by him in 1871 and was defined as "lateral deviation of the first finger of the foot from the medial plane of the body", which, together with the medial deviation of the first metatarsal bone, is accompanied by a static first finger subluxation (Heuter, 1877).

Hallux valgus is diagnosed on the basis of a physical examination and X-rays taken while persons are weight bearing (standing). Two angles are taken into the consideration and being assessed (Deland, 2018):

- **Intermetatarsal angle** – the angle between the first and second metatarsals (the bones that lead up to the bases of the big toe and second toe). If this angle is wider than nine degrees (9°), it is abnormal and referred to as *metatarsus primus varus*.

- **Hallux valgus angle** – the angle of the big toe as it drifts toward the small toe. An angle that exceeds 15° is considered to be a sign of hallux valgus.

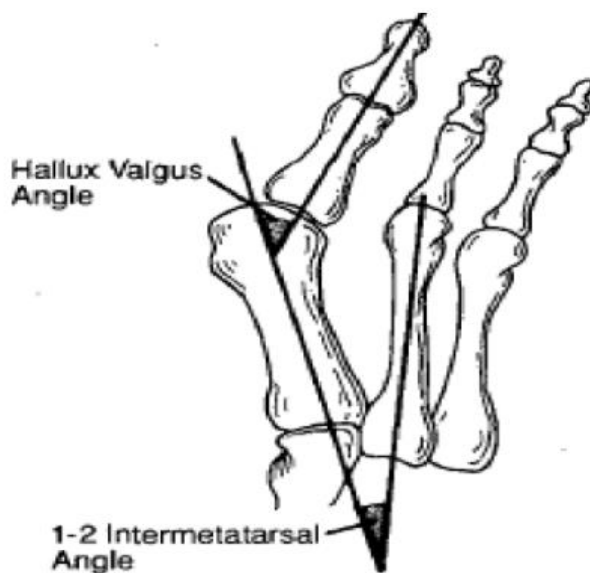


FIGURE 1: The severity of hallux valgus is often diagnosed by the hallux valgus angle and the intermetatarsal angle via radiographic measurement. Reprinted from M.J. Coughlin, 1996, J Bone Joint Surg Am, 78(6), pp. 937

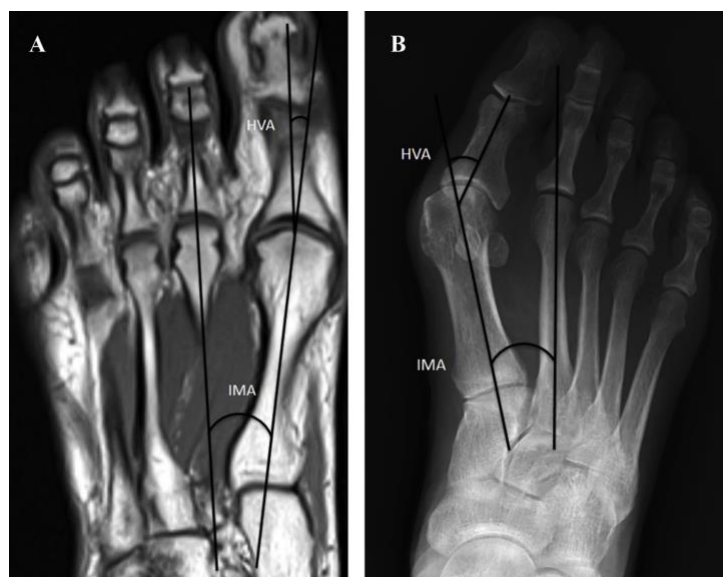


FIGURE 2: HVA and IMA measurements on MRI and x-ray. Hummela, et al., (2019) European Journal of Radiology. VOLUME 113, P24-31

Radiography (X-rays) - along with clinical examination is one of the most common methods of diagnosis of static deformities of the foot in various projections. Radiography is used to accurately characterize the bone vaults of the foot, the position, size and shape of the bones forming the foot, objective examination and the dynamics of vault changes during various treatments (Coetzee., 2003). X-rays are also used to estimate the ratio of the head of the first metatarsal bone to sesame bones, the presence of degenerative changes in the joints of the foot and the amount of medial elevation (Magnan, et al., 2006). Hallux valgus angle is also measured using the goniometer. The center of rotation of the goniometer is placed on the MTP joint space on the medial contour of the foot allowing to measure the hallux valgus angle (Janssen, et al., 2014). The angles are used to assess the severity of valgus deformation of the anterior foot (Coughlin, et al., 2001).

The clinical foot examination and anamnesis collection are performed to make a preliminary diagnosis on hallux valgus. The doctor must assess:

- the severity of gait change;
- degree of joint curvature;
- presence of calluses;
- bone cone.

During the examination of the leg, a molten foot with visible deformation of the first plus phalangeal joint, with possible hyperemia of the protruding "bone" attracts attention. The first toe is deflected towards the second toe, which can also be displaced. At palpation painfulness is possible. If asked to move the finger, the movement will be limited, and their amplitude will depend on the degree of deformation. There are corns and corns on the sole under 2-3 fingers. Both legs must be inspected, and their comparative analysis must be made.

The physical examination begins with the patient standing up, as this increases the valgus deviation of the first finger and other deformations (Fraissler, et al., 2016). It is important to assess the position of the back and front of the foot. Flatulent deformation and tension of calf and flounder muscles can often exacerbate the load and provoke pain in the anterior region of the foot (Wapner, et al., 1999). Clinical examination is performed in stages. In the first stage it is necessary to assess the shape of the foot equinus, the suppinus and pronation of the foot, as well as the length of the Achilles tendon (Johnson, et al., 1991). Then evaluate the first ray it is necessary to determine the volume of movement in the first phalangeal joint, the volume of movement in the interphalangeal joint and the valgus installation. During

the examination, past the deformities themselves, inflammatory processes, trophic disorders, corns and calluses can be detected (Schneider, et al., 2002).

Radiography is used to accurately characterize the bone vaults of the foot, the position, size and shape of the bones forming the foot, objective examination and the dynamics of vault changes during treatment (Coetzee, 2003). When measuring the hallux valgus angle, X-rays or goniometers are mainly used to estimate the severity.

Once the doctor examines and recognizes the HV condition, different methods of treatments can be offered and applied. The recommendations also depend on the severity of hallux valgus and it will be discussed in later parts of the thesis.

In the following chapters of my thesis the analysis of the causes, signs and symptoms of hallux valgus together with the severity of the condition will be analyzed in order to fully understand and prove the necessity of physiotherapy treatment appliances.

1.1. Causes and symptoms

Only 20 - 30% of the adult population of the foot remains normal structure. The others have different kinds of defects associated with the plasticity of the front foot and various deformations of the toes - valgus first, hammer and (or) claw second - fourth, varus fifth (Pisani, et al., 1998). Deformation of the anterior foot leads to painful syndrome, its functional failure, causes a gait violation, is cause of a cosmetic defect, limits the use of conventional shoes, may reduce a person's social and labor activity. The importance of the problem of treatment of this pathology is due to that role, that the foot plays in the locomotive function of the lower limb, being its main segment that provides the perception of static and dynamic load, as well as movement. Widespread deformations of the front foot in connection with the working and living conditions of the person, significant influence of this pathologies for ability to work give the right to consider this pathology not only medical, but also social and economic problem. According to the data of the World Health Organization, 75% of the world's population have problems associated with foot pathology that seriously interfere with people's lifestyle (Zwipp, 1994). Hallux Valgus occurs in approximately 23% of adults aged 18 to 65 years and up 36% of adults older than 65 years old. When looking at adult females, HV deformity occurs as high as 30% (Nix, et al., 2010).

Universally accepted that hallux valgus arises in steps, which do not necessarily occur in series but may occur in parallel. The precise etiology of hallux valgus deformity is unknown. Much research has confirmed the multifactorial origins of hallux valgus, which include several predisposing extrinsic factors such as high-heeled narrow shoes and excessive weight-bearing.

Even though the etiology of hallux valgus is not well established - certain factors have been considered and **causes** are commonly divided into such bullet points (Golightly, et al., 2015):

- Gender (the condition is significantly more frequent in women);
- Age;
- Footwear (tight pointed shoes);
- Congenital deformity or predisposition;
- Chronic achilles tightness;
- Severe flatfoot;
- Hypermobility of the first metatarsocuneiform joint;
- Systemic disease;
- Possible that abnormal muscle insertions are partly responsible for hallux valgus;
- Hallux valgus is also associated with hip and knee OA (osteoarthritis) and is inversely associated with a higher BMI.

The hallux valgus condition is mainly diagnosed for women. Women are more likely to wear tight, narrow shoes that squeeze the toes together and this is one of the reasons why the condition is significantly more frequent in the female population. In addition, women's joints are known to be more flexible than men's, which lead to greater deformity when an abductory force is applied (Larsson, et al., 1987).

Hallux valgus tends to get more disturbing with an increasing age. Increasing age is associated with a greater reduction in size of the abductor hallucis muscle in people with hallux valgus. People over the age of 65 years old with hallux valgus display a significant reduction in abductor hallucis muscle size compared to those aged less than 45 years old (Aiyer, et al., 2015).

Wearing tight shoes also affects the development of hallux valgus. If a footwear cannot fulfil its intended purpose and if it does not fit the foot correctly it causes various foot deformities including hallux valgus. It has been widely suggested that incorrectly fitted footwear is a major contributor to the development of structural foot disorders (Frey C, 2000). To slow down the hallux valgus progression, amount of deformity, even the occurrence of Stage 1 HV, it is recommended to choose the right footwear. Many orthopedic shoes manufacturers have researched and made the specific footwear for people with foot deformities and also divided some main keys to the right footwear (Janisse, et al., 2008). They emphasize the importance of such characteristics:

- **Width:** it is recommended to wear wide shoes and sometimes even extra wide shoes to accommodate the wide splay foot that develops with bunions. The wide width will not squeeze the foot and create a pressure free environment for the bunion.
- **Toe box:** choosing the right shape of the toe box in the front of the shoe - it has to be round and not pointed.
- **Orthotic insole:** an orthotic can slow down the continued worsening of the deformity and reduce pain by redistributing forces on the damaged forefoot joints.
- **Extra depth:** an extra depth shoe generally has more total room and the ability to handle an insert. Orthofeet shoes are extra deep to allow accommodation for the deformity and a custom insole.
- **Soft interiors:** having a soft seamless inner lining that is padded with foam and a flexible outer material or uppers without overlays, provide gentle contact with the bunion and help relieve bunion pain.
- **Stretch fabric uppers:** when the shoes are constructed with materials that can stretch, they conform to the contours of the foot, hence the bunion bump, and don't apply any pressure on it.
- **Heel to toe drop:** the best shoes need to be low to the ground with low heels as any heel height is counter-productive to a forefoot with bunions and/or tailor's bunions.
- **Heel counter:** Shoes should also have a firm heel counter and firm outsole for stability. Pronation, which is excess motion of the foot, causes bunions to form and continue to progress. Footwear must be stable to reduce the pronation motion.

Congenital deformity or predisposition refers to the fact that hallux valgus can also have a pattern of inheritance. Studies show that the risk of developing bunions is greater for first-degree relatives of affected individuals (such as siblings or children) as compared to the general public. When bunions occur as part of a genetic syndrome, this feature follows the inheritance pattern of the syndrome (Pique-Vidal, et al., 2007).

Severe flatfoot is also known as one of the causes for hallux valgus (Crevoisier, et al., 2016). Patients with flatfoot have a higher odds of hallux valgus. Flatfoot may lead to hallux valgus due to increased forefoot abduction that creates a nonphysiologic load on the plantar medial aspect of the great toe during heel rise so the load on the feet is also unevenly distributed. In other words, a foot is designed like a tripod (Manoli, et al., 2005) which is made of a big toe, small toe and a heel. In a foot supposed to be two arches one between the big toe and the heel, the second arche supposed to be across the middle of a foot (medial to lateral) which is from big toe to a small toe.

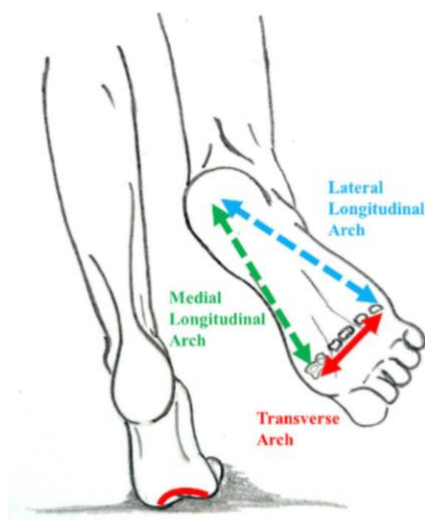


FIGURE 3: Representation of the three arches of the foot. The transverse arch is marked in red and it is in contact with the ground during terminal stance. Zeidan, et al., (2019) Comparison of the Changes in the Structure of the Transverse Arch of the Normal and Hallux Valgus Feet under Different Loading Positions.

With the flatfoot most of the medial point of the foot is pushed over and it causes pronation while receiving a lot of force on the side of a big toe. With the flatfoot feet loses longitudinal arch the big toe

is pushed over and more pressure is on the side of the toe the more it gets pushed over and the narrower feet tripod becomes this ends up precipitating and speeding the progress of hallux valgus. The role of flatfoot is a really important initiating factor for valgus deformation, and, in the presence of longitudinal flatfoot, deformation progresses faster (Easley, et al., 1996).

Hypermobility of the first metatarsocuneiform joint is another reason for the development of transverse flat feet and hallux valgus is the hypermobility of the first metatarsal joint (Klaue, et al., 1994). Joint hypermobility – allowing forefoot/metatarsal arch to easily collapse upon weight-bearing. Most common cause of juvenile hallux valgus. Hypermobility of the first MTT contributes significantly to the development of hallux valgus and plays an important role even in its treatment. Morton (Morton, 1928) in 1928 was the first to describe hypermobility and instability of the first MTT in the sagittal plane. Lapidus (Obster, 1934) found that increasing hypermobility of the first MTT leads to development of hallux valgus.

Falling under the circumstances that highly initiate the appearance of hallux valgus condition - a person must be cautious and not ignore the fact that together with such deformity, the quality of life can be affected not only in a visual, esthetical way, but it brings discomfort and pain to a daily life's routine. From picking comfortable rather than trendy shoes, to more serious issues - an elderly person may also consider staying at home due to chances to lose balance and also increased chances to fall. The Hallux Valgus **symptoms** are (Smith, 2019):

- pain and soreness;
- numbness;
- a burning sensation;
- swelling at the joint of the affected toe;
- increased skin thickness at the base of the affected toe;
- hardened skin under the foot;
- redness;
- bump on the base of the affected toe;
- the presence of corns or calluses;
- movement restriction within the affected toe.

The intensity of foot pain experienced by individuals with HV is not determined by angular deformity or other passive structural factors, but rather is influenced by patient characteristics such as poorer general health status and increased occupational physical activity levels. In addition to patient factors, some dynamic foot and ankle characteristics were significantly associated with increasing foot pain (Hurn, et al., 2014). If the bulge is big, it might hurt when wearing even wide shoes. HV can sometimes damage nerves in the big toe, leading to numbness. With HV often occurs Peripheral neuropathy (a burning sensation).

1.2. Severity & stages of hallux valgus

Hallux valgus is diagnosed when the hallux valgus angle is greater than 15 degrees (Ferrari, 2014). The severity of the deformity (Coughlin, 1996a) is characterized by the hallux valgus angle and the intermetatarsal angle. The classification is mild, moderate, and severe based on the weight-bearing anteroposterior, lateral oblique, lateral, and sesamoid axial views. This classification helps evaluate the structural status of the foot degree: Hallux valgus angle (HVA) / Intermetatarsal angle (IMA) (Kuhn, et al., 2020):

- Normal: less than 15 degrees / 9 degrees
- Mild: 15 to 30 degrees / 9 to 13 degrees
- Moderate: 30 to 40 degrees / 13 to 20 degrees
- Severe: over 40 degrees / over 20 degrees



Figure 4. Grading of hallux valgus using the Manchester scale. (a) No deformity; (b) mild deformity; (c) moderate deformity; (d) severe deformity. Menz, et al., (2005) Radiographic validation of the Manchester scale for the classification of hallux valgus deformity. *Rheumatology* 44(8):1061-6.

Also, four stages of HV development have been picked out by Gilheany MF, Landorf KB, Robinson P. in their scientific work “Hallux valgus and hallux rigidus: a comparison of impact on health-related quality of life in patients presenting to foot surgeons in Australia. *J Foot Ankle Res*” (Gilheany, et al., 2008).

- Stage 1: Lateral displacement of the hallux at the MTP joint
- Stage 2: Progression of the hallux abduction (hallux pressing against the second toe)
- Stage 3: Increased intermetatarsal angle, possible associated second hammertoe deformity
- Stage 4: Partial/Complete hallux dislocation at the MTP joint

The methods of treatments applied by physiotherapists may vary depending on the severity and stages of HV. The following chapter provides the analysis of different treatment methods applied in order to reduce Hallux Valgus angle and improve gait patterns and balance.

1.3. Methods of hallux valgus treatment

One of the complex treatments for HV is physiotherapy. Physiotherapy treatment strengthens muscles, increases joint mobility, which reduces pain and discomfort, and prevents the progression of deformity. The type and manifestation of deformation is different in different patients, and patients are different from each other in their daily activities by their expectations from the treatment. In physiotherapeutic practice, patients with hallux valgus are normally treated with physiotherapy procedures. Various methods of conservative treatment are applied in order to reduce pain, decrease angle and improve gait and balance patterns before making a decision to proceed with a surgery. As shown by the results of the studies conducted by various authors, the use of interactions in the area of physiotherapy and orthopedic measures can bring beneficial results in treating HV.

Specific exercises can be used to treat HV. Several researchers have suggested that exercise is necessary during the early stages of HV, to prevent further increases in the HV angle (Incel, et al., 2003). One of the “most conservative” methods of treatment of valgus deformation of the first toe **is orthosis and correct selection of shoes**. Soft leather shoes with extra width and depth for the toes can alleviate symptoms in many patients. However, there is no evidence that wearing orthopedic shoes prevents the development of valgus deformation of the first finger (Menz, et al., 2001). Orthosis is often applied together with another physiotherapy method for treating HV, as a combination, for more efficient results.

There are a lot of physiotherapy methods applied for patients with Hallux Valgus, such as cold laser therapy, ultrasound, cryotherapy, low frequency magnetic field shock wave. Since the bachelor thesis covers the two effects of physiotherapy methods for HV: angle reduction and gait pattern and balance improvement, the methods chosen and analyzed in the empirical part are the methods mainly applied for HV angle reduction or improvement of gait pattern and balance. These methods include rigid taping, corrective taping, conventional tape, kinesio taping and joint mobilization, stretching, toe spread out.

The common exercise is by Doug Keller who introduced the “**Toe-Spread-Out**” exercise. The subsequent electromyographic study revealed greater activation of the abductor hallucis muscle during performance of the exercise than during the short foot exercise, in patients that have mild HV (Keller, 2008). The instructions are to lift all toes while keeping the metatarsal heads and heel on the floor, and to then push the little toe downward, in a lateral direction, while pushing the big toe slowly downward in a medial direction.

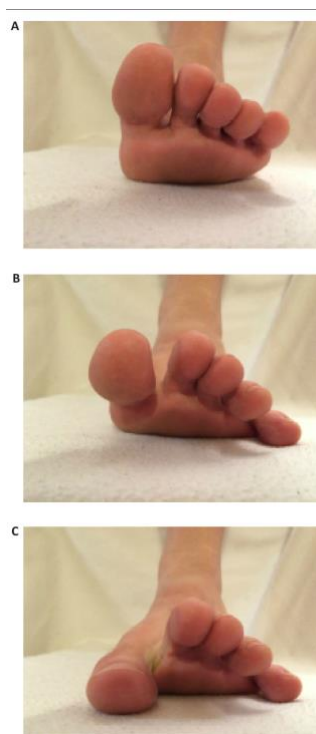


Figure 5. The phases of TSO exercise. A dorsiflexion of the toes keeping the metatarsal heads and the heel on the ground, B moving the fifth toe down and to the lateral direction, C moving the great toe down and abduction. Mortka, et al., 2016 A. The toe spread out exercise in patients with hallux valgus. *Issue Rehabil. Orthop. Neurophysiol. Sport Promot.* 2016; 16: 41–50.

It is hypothesized that wearing an orthosis, in conjunction with performing “Toe-Spread-Out” exercises, would decrease the HV angle, and the HV angle during active abduction (Moon-Hwan, et al., 2015). Therefore, the combinations of physiotherapy treatments are a common practice.

There are various taping techniques, applied for patients with Hallux Valgus and the techniques tend to be one of the most popular ones. **Kinesio taping** is a method designed to mimic the qualities of

human skin (Thelen, et al., 2008). It is considered to be an effective treatment option in decreasing pain and deformity in hallux valgus deformity for patients who are conservatively treated (Karabicak, 2015).



Figure 6. Kinesio Taping. Radwan, et al., (2017) Conventional Tape versus Kinesiotape for Hallux Valgus Correction. International Journal of Medical Research & Health Sciences, 6(1): 71-78

It is suggested that kinesio taping, when combined with exercises, proved to be an effective method in HV treatment as a significant decrease was observed in the HV angle and in the referred pain. However, it is difficult to guarantee whether such decrease is permanent or temporary due to the use of the tape (Schmitt, et al., 2019).

Mulligan Taping mainly utilizes the “mobilization with movement” techniques, according to which there is a certain direction of application of mobilization forces, which if maintained during a painful movement. Repetitions of the pain-free “mobilization with movement” are required in order to achieve an efficient therapeutic result, eventually with the additional application of overpressure, with immediate positive results even within the first treatment session (Hing, et al., 2015). **Corrective taping**, although a form of conservative treatment for hallux valgus, has also been introduced and studied in terms of effects on balance. Although HV has been demonstrated to impair postural balance, there is a lack of information about how corrective taping affects balance and gait patterns in adults with HV deformity (Gur, et al., 2017).

As it was noticed, various physiotherapy’s methods are combined together in order to reach the most efficient results in treating patients. The common combination is taping and exercises. One of the options for angle reduction and balance improvement are joint **mobilization** and **stretching**. Joint mobilization is a physical therapy technique designed to relieve pain, muscle spasms and release tension

together with improved flexibility in a joint. By increasing patients' awareness of the correct position and movement of a joint and simulating smooth joint function, joint mobilization improves range of motion and mobility (The Orthopedic Hand and Arm Center, 2020). If a bunion and a big toe may not be moving correctly, physical therapists may even teach patients self-stretching techniques to help restore normal motion of the foot, ankle, and toes (Physical Therapy Guide to Bunion (Hallux Valgus) 2020).

Many researchers turned their studies into the available medical literature that would justify appliance of physiotherapy, based on its effectiveness for patients with hallux valgus and for hallux valgus angle reduction and gait pattern and balance improvement. The most common benefits are believed to be reduction in pain and correction of deformity with the methods used alone or in combination with other conservative treatments. Even if physiotherapy only inhibits further deformation, it should be recognized as a therapeutic success - the results are often comparable to surgical outcomes and it is a must to emphasize that conservative methods do not cause any complication. An additional benefit of conservative approaches is the costs associated with surgery are avoided. Physical therapy, exercises, night splints or tapes are usually cheaper and more readily available (Mortka, et al., 2015).

1.3.1 Evaluation of methods applied for patients with hallux valgus

Hallux valgus angle is measured using radiograph or the goniometer of the barefoot participants. Using a goniometer, the feet of a patient must be weight-bearing and in a normal standing position. The center of rotation of the goniometer is placed on the MTP joint space on the medial contour of the foot. One arm of the goniometer is placed parallel to the medial contour of the first metatarsal and the other parallel to the medial contour of the proximal phalanx of the hallux (Janssen, et al., 2014). Only trained doctors, physical therapists or other personnel with prior training must be allowed to use the goniometers. The person must know how to position, stabilize the joint correctly, set appropriate range of motion (ROM), determine the joint's end of the range-of-motion and end-feel, palpate the appropriate bony landmarks, align the goniometer with the landmarks, read the measuring instrument properly and record measurements correctly. Complications related to goniometry are limited, and mainly due to faulty techniques. They are as follows:

- error of measurement - inaccurate measurements due to faulty technique;
- Iatrogenic injuries

Forceful joint range of motion during goniometry may cause an iatrogenic fracture in weak osteoporotic bones (Viraj, et al., 2020). Even though a goniometry can be used as an inexpensive and radiation free alternative, it is discussed, that computerized measurement may result in more reliable readings and it eliminates the error inherent with use of a goniometer and facilitates adjustment of radiographic lines on the computer to ensure correct alignment (Farber, et al., 2005). However, other studies of the HVA measured manually using a goniometer or with the radiograph shows similar results and is proven to be a reliable technique (Pique-Vidal, et al., 2005).

Balance is usually measured using the LoS (Limits of Stability test) which is defined as the points at which the center of gravity approaches the limits of the base of support and a correction strategy is required to return the center of mass to within the base of support (Huo, F. 1999. Limits of stability and postural sway in young and older people. Queen's University at Kingston). The LoS test is used to assess dynamic balance. The test is a good indicator of control within a normalized sway envelope. The subjects are measured in stance position, instructed to lean forward, then backward, left and right as much as they can, without bending the hips or lifting the toes, heels off the ground. Each patient must shift their weight to move the cursor from the center target to a blinking target and back as quickly and with as little deviation as possible (Gur, et al, 2016).

The SUO test (ascending and descending stairs) and the WA test (for measuring a gait) is also used to assess dynamic balance in functional activities. In SUO test, the patient stands in front of a raised platform, steps onto the platform with the leading leg, and swing the opposing leg over the platform and down onto the surface on the opposite side (Gur, et al, 2016). The WA test shows quantified characteristics of gait as the patient walks across the length of the force plate. During the WA test, which assesses stability during gait, the patient stands approximately 1m before the start of the long plate and then walks at his/ her comfortable walking pace using his/ her usual indoor gait across the long plate. Step width, step length, and speed are the performance measures for the WA test (Gur, et al, 2016).

The mCTSIB is a simplified derivative of the sensory organization test that provides objective evidence of sensory dysfunction. This test was designed to assess how well an adult is using sensory inputs when 1 or more sensory systems are compromised (Gur, et al., 2016).

The Romberg test is an appropriate tool to diagnose sensory ataxia, a gait disturbance caused by abnormal proprioception involving information about the location of the joints. The Romberg test is used for the clinical assessment of patients with disequilibrium or ataxia from sensory and motor disorders (Kim S, et al., 2012).

EMPIRICAL PART

2. METHODS OF RESEARCH

- PubMed
- Sage Journals
- ResearchGate
- Google Scholar
- Koreascience

The following words or combinations were used to search for articles in the databases: hallux valgus, bunions, hallux valgus angle, hallux valgus taping techniques, kinesio taping, hallux valgus kinesio taping, kinesio taping on foot deformation, gait, balance.

Intended criteria for inclusion of scientific articles:

- The article evaluates the application of the kinesio tape to the deformation of hallux valgus;
- The article evaluates the effect taping techniques on balance improvement;
- The article evaluates the effect of physiotherapy on hallux valgus gait correction;
- The article evaluates the effect of exercises on hallux valgus gait correction;
- The article evaluates the effect of kinesio tape on hallux valgus angle reduction;
- The article evaluates the effect of stretching on hallux valgus angle reduction;
- The article was published in English language;
- Research articles and full texts;
- Free access to the publications.

Intended exclusion criteria for scientific articles:

- The article was published in a language other than English;
- There are no clear results;

- There is no clear intervention;
- The article does not describe the effect of kinesio tape on balance in case of hallux valgus deformation;
- The article does not describe the effect of taping on gait change in the presence of hallux valgus deformation;
- The article does not describe the effect of stretching on angle or gait improvement in hallux valgus deformation;

All articles of the systematic review were included that met the inclusion criteria set out in the table.

Table 1. Inclusion and exclusion criteria.

Criteria	Inclusion criteria	Exclusion criteria
Language	English	Other foreign language
Deformation	Hallux Valgus	Other deformations
Type of the article	Scientific articles and complete texts	Scientific reviews, meta-analyzes, completion of graduation work.
Article publishing year	2015 - 2020	Older than 2015 articles
Age	18 - 60 years old participants	Under 18 years old participants
Publication availability	Freely available articles from home	Article access restricted from home
Methodology	Taping; Stretching; Joint-Mobilization, Toe-Spread-Out, Orthosis;	Other methodologies
The survey	Individuals with hallux valgus deformation.	Individuals without HV deformation

On the research of scientific sources have been found 340 articles, but after research selection 5 articles were examined according to the inclusion and exclusion criteria. In Science research the selection scheme is given in Table 2. Scientific articles have examined the kinesio tape effects on foot function in the presence of hallux valgus deformity. Of the 340 articles, articles were rejected older than 5 years 120, articles in non-English 72, by title and summary rejected Articles 90 were also rejected due to inaccuracies in Article 42. In Table 3 below the general aspects considered and the general results of the articles are presented.

Table 2. Research selection process.

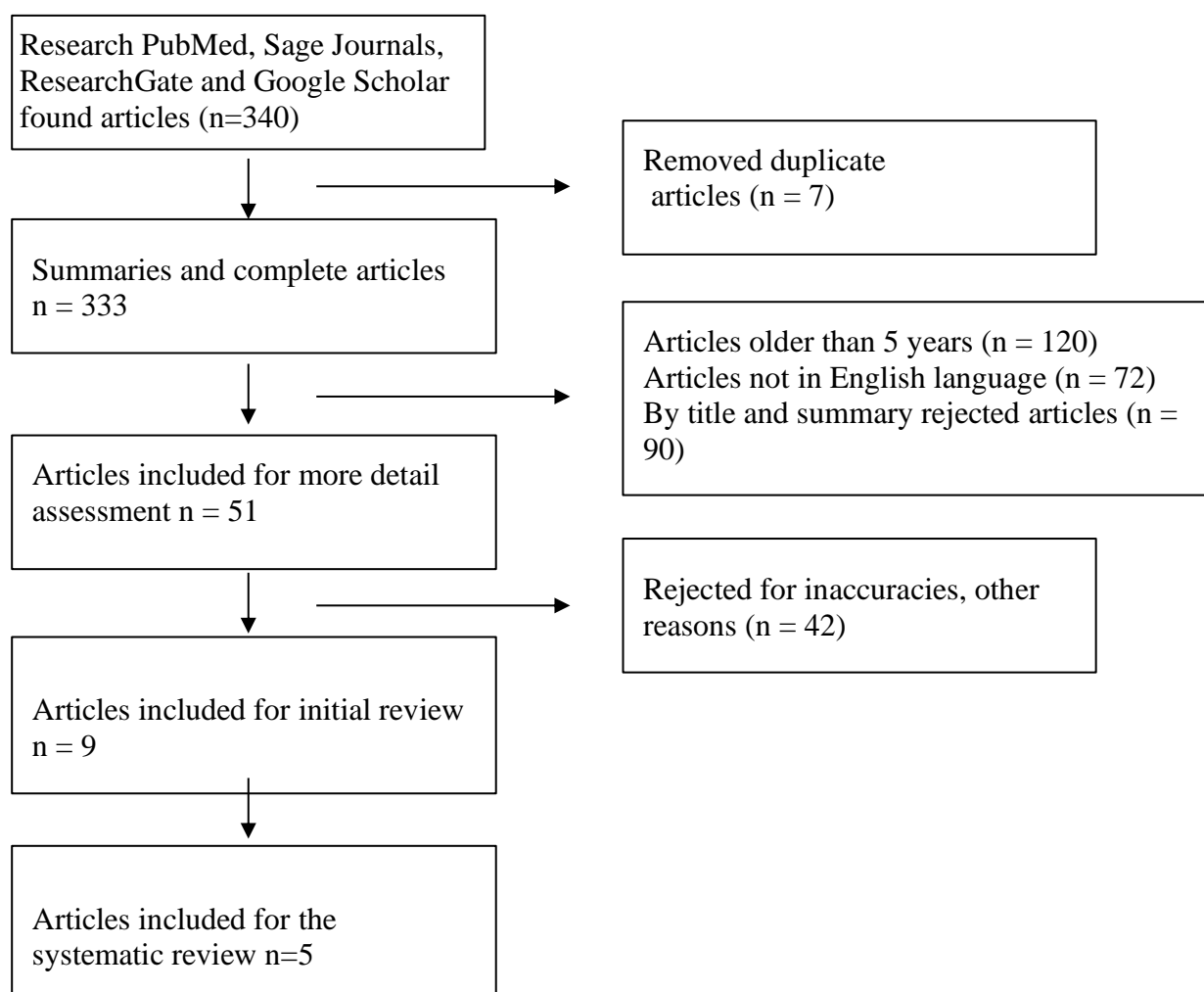


Table 3. General overview of articles.

Author name, last name, Article Publication year.	HVA	Gait	Balance	Results
Radwan et al. 2017	+	-	-	In the kinesio taping group, the hallux valgus angle in the right leg decreased from 28.33 to 16.40 degrees, and the Intermetatarsal angle decreased from 13.67 to 8.40 degrees. In the left foot the hallux valgus angle decreased from 29 to 18.73 degrees. Intermetatarsal angle decreased from 14.33 to 8.33 degree. In the conventional group hallux valgus angle in the right foot decreased from 28.73 to 19.07 degrees and Intermetatarsal angle decreased from 14.10 to 9.47 degrees. In the left foot, the hallux valgus angle decreased from 30.33 to 21.60, the Intermetatarsal angle decreased from 15.13 to 9.53 degrees.
Choi et al. 2017	+	-	-	Both the KT and KTJM groups showed a significant decrease in the angle of the metatarsophalangeal joint from 20.47 ± 4.17 to 17.23 ± 4.27 in the KT group. And from 20.51 ± 3.76 to 15.47 ± 4.31 in the KTJM group.
Moon-Hwan et al. 2015	+	-	-	Was a significant decrease in the HV angle, and the HV angle during active abduction. In the orthosis group from 19.25 ± 3.25 to 18.75 ± 3.52 . Best results have shown the Orthosis plus TSO exercise group from 18.33 ± 3.42 to 14.92 ± 3.36 .
Esedullah Akaras et al. 2020	+	+	+	HVA were reduced in all taping groups ($p < 0.05$). The Mulligan method of taping was the most effective method in reducing hallux valgus angle. Foot motor performance was not affected by any type of taping ($p > 0.05$). Although a method of athletic taping increased step length and step width but reduced foot angle and cadency. The

				method of Mulligan taping increased cadency and reduced angle of the foot by ($p < 0.01$). Either the Mulligan nor athletic taping methods did not affect the postural stability and fall risk ($p > 0.05$). Stability limits were increased in Mulligan taping group ($p < 0.05$).
Jung-Hyun Choi, 2017	+		+	Angle before and after intervention was significantly reduced in the stretching group from 15.57 ± 3.61 to 13.46 ± 4.12 , taping group from 15.02 ± 2.61 to 12.56 ± 2.80 , and stretching with taping group from 16.56 ± 4.01 to 14.00 ± 3.97 .

2.1. Distribution of subjects by gender

A total of 139 individuals participated in the examined articles, including 114 women and 25 men. From these articles examined, Table 4 suggests that women are more likely to experience hallux valgus deformity than men. Subjects range in age from 18 to 64 years. Table 5 provides information on the duration of the study and the methodologies used.

Table 4. Information on the distribution of subjects by sex and age.

Author of the article	Women	Men	Age
Radwan et al. 2017	30	-	45-60
Choi et al. 2017	21	-	20-30
Moon-Hwan et al. 2015	11	13	19-29
Esedullah Akaras et al. 2020	10	12	18-35

Jung-Hyun Choi, 2017	24	-	20-30
In total:	96	25	18-60

Table 5. In the articles used research duration, intervention, and investigation.

Author	Duration of the study	Intervention	Investigation
Radwan et al. 2017	8 weeks	Kinesiotape was applied every 5 days. Conventional tape was applied 2 times a day and exercises that was performed 3 times a day with 10 repetitions.	Goniometer
Choi et al. 2017	6 weeks	Kinesiotape was applied every 3 days and joint mobilization exercises were performed 3 times per week.	Goniometer
Moon-Hwan et al. 2015	8 weeks	Orthosis was worn for an 8-week period. TSO exercises were performed for 20 min/day, 4 days/week	Radiography and Ultrasonography
Esedullah Akaras et al. 2020	12 days	New tape was applied every 3 days.	Goniometer, Powdered ground footprint method and Biodex Portable Biosway, LoS and CTSIB test.

Jung-Hyun Choi, 2017	6 weeks	Kinesiotaping was applied once every 7th day. Stretching exercise using the elastic band was performed 3 times a week for 6 weeks with the AC and HR-AC exercises.	Goniometer, Romberg test and LoS test.
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3. THE EFFECTS OF PHYSIOTHERAPY METHODS OF HALLUX VALGUS TREATMENT FOR ANGLE REDUCTION

3.1. Conventional tape and kinesiotape

Conventional Tape versus Kinesiotape for Hallux Valgus Correction (Nadia Lotfy Radwan, Mervat Abdelrahman Mohamed, Abeer Ramadan Ibrahim, 2017)

Aim of the research - This study was commenced to compare the effect of kinesiotape opposed to conventional tape on hallux valgus angle and intermetatarsal angle as well as the intensity of pain from hallux valgus deformity.

Method: 30 female participants ranged age between 45 and 60 years old with hallux valgus angle diagnostics between twenty to forty degrees. The participants were randomly assigned into two groups each group of 15. Group 1 (The Kinesio tape group) and Group 2 (The Conventional tape group). Duration of study was 8 weeks.

Inclusion criteria:

- Women between 40 to 60 years old;
- Hallux valgus angle mild to moderate (20-40 degrees);
- Bilateral flexible hallux valgus.

Exclusion criteria:

- Participants who had evidence of lower extremity malalignments;
- Limitations in the abduction movement of the hallux valgus;
- History of the previous foot surgeries;
- Previous usage of foot orthoses.

Application:

The Kinesio Tape group participants were taped with two Y-shaped pieces, the first Y-shaped strip's base was placed on the base of the hallux. The tape was implemented through the first ray when the big toe was aligned to its estimated correct position with a light to moderate tension.

The second tape piece was placed over the metatarsophalangeal joint. After tape application, patients were allowed to walk for 10 min to be adapted with the tape. The Conventional tape group applied two strips of 2 centimeters and 3.8 centimeters accordingly placed on the distal toe at the base of the toenail and on the instep and the arch of the foot. Participants were asked to do the taping twice daily. Both groups were asked to do exercises 3 times a day after 10 repetitions for a duration of 56 days. The exercises were designed for passive hallux withdrawal with traction during the first metatarsophalangeal joint and active hallux attraction.

Results:

In the kinesio taping group, the hallux valgus angle in the right leg decreased from 28.33 to 16.40 degrees, and the Intermetatarsal angle decreased from 13.67 to 8.40 degrees. In the left foot the hallux valgus angle decreased from 29 to 18.73 degrees. Intermetatarsal angle decreased from 14.33 to 8.33 degrees. In the conventional group hallux valgus angle in the right foot decreased from 28.73 to 19.07 degrees and Intermetatarsal angle decreased from 14.10 to 9.47 degrees. In the left foot, the hallux valgus angle decreased from 30.33 to 21.60, the Intermetatarsal angle decreased from 15.13 to 9.53 degrees.

3.2. Kinesio taping and joint mobilization

Effect of Kinesiotaping and Joint Mobilization on The Metatarsophalangeal Joint Angle and Pain in Hallux Valgus Patients (Jung Hyun Choi 2017)

Aim of the research - to observe the effects of kinesio taping and joint mobilization on the metatarsophalangeal joint angle and pain in hallux valgus patients.

Method: Twenty-one female hallux valgus participants in their 20s were divided into two additional groups: first group was a kinesio taping group and consisted of 10 participants. Another group with the addition of joint mobilization to kinesio taping consisted of 11 participants. Study duration was 42 days. In order to measure the change in foot angle, a radiographic examination was performed. Radiographs were taken bilaterally with the foot in dorsiflexion.

Inclusion criteria:

- Participants age not younger than 20
- Participants age not older than 30
- HVA less than 25 degrees;
- No other podiatric disorders;

Exclusion criteria:

- Other podiatric disorders such as achilles tendonitis and etc.
- Hallux Valgus larger than 25 degrees;
- Participants age older than 30;
- Participants age less than 20;

Application:

In the KT group to ensure the elasticity of the tape, each strip was cut 1/4 of the measured length before application and every 3 days, the elasticity and state of adhesion was checked. Details of the application follows: Starting from the outside of the foot, the tape was stretched across the top of the foot

and wrapped under and in front the distal joint of the 1st phalange, passing the inner sole. From the outside of the foot, the bottom of the 1st metatarsal joint was crossed and with toes adducted, the tape was passed through the 1st and 2nd phalange, before wrapping around and pulling the 1st phalange back. To ensure that the tape did not attach to the toenail, the width of the tape was cut accordingly. For the finish, a narrow strip of tape was wrapped around the portion of the 1st phalange where the toenail ended, being careful to ensure once again that the tape did not adhere to the toenail itself.

In the KTJM group participants underwent joint mobilization 3 times every week. The kinesio taping for the second group was conducted in the same manner as in the first group. The joint mobilization technique was assessed with the proximal hand placed close to the MTP joint line in order to stabilize the metatarsus, while the distal hand was placed on the proximal phalanx. The direction of joint mobilization was aimed laterally with a grade III level of intensity. The rhythm of the mobilization used was staccato and the speed was medium (1 oscillation per 1 second) for a duration of 1 minute with 5 sessions per day. The participants were instructed to stand on one foot with the radiograph taken at 15°, at a distance of 40 inches, and the aim centered around the navicular bone. With the angle of the hallux valgus being created by the 1st metatarsal bone and the long axis of the 1st proximal phalanx, the angle between the major axis of the 1st and 2nd metatarsal bones were measured.

Results:

Both the KT and KTJM groups showed a significant decrease in the angle of the metatarsophalangeal joint from 20.47 ± 4.17 to 17.23 ± 4.27 in the KT group. And from 20.51 ± 3.76 to 15.47 ± 4.31 in the KTJM group.

3.3. Orthosis and toe-spread-out

Effect of toe-spread-out exercise on hallux valgus angle and cross-sectional area of abductor hallucis muscle in subjects with hallux valgus (Moon-Hwan Kim, 2015)

Aim of the research - to study whether the toe-spread-out exercise affects the hallux valgus angle, the cross-sectional area of the abductor hallucis muscle, and the hallux valgus angle during active abduction.

Method: 24 participants (11 females and 13 males) with HV randomly divided into two groups: orthosis and orthosis plus toe-spread-out exercise. Study lasted for 56 days. The orthosis group wore the orthosis for 8 weeks. Orthosis plus toe-spread-out group also performed the toe-spread-out exercise. Every participant wore an appropriately sized orthosis, made of the spandex material, the Bunion sleeve was required to wear not more than 8 hours each day. The HVA was measured initially and then after 8 weeks by radiography and ultrasonography. Also, the independent t-test was used to assess the significance of between-group differences in the initial value of the HV angle, the CSA of the AbdH muscle, and the HV angle during active abduction.

Inclusion criteria:

- HV angle no less than 15 degrees.

Exclusion criteria:

- Diagnosis of rheumatoid arthritis;
- Diagnosis of osteoarthritis;
- Had a foot surgery;
- Previous use of a foot orthosis;
- Previously diagnosed central or peripheral nervous system injury.

Application:

Subjects were required to wear the orthosis for > 8 h/day. Subjects in the orthosis plus TSO exercise group were trained to perform the TSO exercise following the method described by Keller. The participants were instructed to lift all their toes while keeping the metatarsal heads and heel on the ground, and to then to push their little toe downward, in a lateral direction, while simultaneously pushing the big toe slowly downward in a medial direction. Prior to the commencement of the experiment, training exercises were performed for 2 days, for a total of 2 hours. Between the rest of the experimental day and the end of the study, participants performed the TSO exercise for 20 minutes a day, 4 days a week. On a single occasion each week, the orthosis plus TSO exercise group received 30 minutes of instruction from a supervisor regarding correct performance of the TSO exercise. All subjects were evaluated before and after the study, with respect to HV angle, CSA of the AbdH muscle, and HV angle during active abduction.

Results:

After 8 weeks, there was a significant decrease in the HV angle, and the HV angle during active abduction. In the orthosis group from 19.25 ± 3.25 to 18.75 ± 3.52 . Best results have shown the Orthosis plus TSO exercise group from 18.33 ± 3.42 to 14.92 ± 3.36 .

4. THE EFFECTS OF PHYSIOTHERAPY METHODS OF HALLUX VALGUS TREATMENT FOR GAIT PATTERNS AND BALANCE

4.1. Rigid taping

The acute effects of two different rigid taping methods in patients with hallux valgus deformity (Esedullah Akaras et al. 2020).

Aim of the research - to measure and compare the acute effects of two different rigid taping methods such as Athletic and Mulligan taping on hallux valgus angle, foot motor performance, balance and gait in patients with HV deformity.

Method: 22 voluntary participants (twelve males and ten females) with flexible HV deformities between 18 and 35 years of age were included. Rigid athletic and Mulligan tapings were applied. All measurements were done before and after placebo. To evaluate gait spatiotemporal parameters “Powdered ground footprint method” was applied. Balance, parameters of gait and foot motor performance were evaluated. “Biodex Portable Biosway” balance device was used for measuring static balance. Cases were randomly assessed 4 times, as Mulligan, Athletic, Placebo taping and no-tape group, using Random Allocation Software 2.0.0 version.

Inclusion criteria:

- Not rigid deformities in the right foot
- HVA above 15 degrees
- Volunteering Approval.

Exclusion criteria:

- History of lower extremity surgery
- Mental and psychological issues
- Rheumatoid arthritis
- Systemic diseases

- Hysterical and neurological problems
- Skin lesions
- Allergies.

Application:

Placebo, Mulligan and Athletic taping techniques were applied to participants. Measurements were taken after fitting for half an hour to the tape. For the placebo group, a taping method was applied. A protape of the T-shape was cut and then applied to the medial part of the foot without stretch force. Mulligan taping was applied from the lower part of the foot to the lateral and was terminated at the lateral and upper aspect of the foot while hallux was abducted and externally rotated while participants were sitting in neutral position. Athletic taping was cut in circumferential rounds and applied when the foot was in neutral position while pulling the toe to the base of the foot towards the medial side of the foot.

- Measurements of the hallux valgus angle was done by goniometer from the upper dorsal aspect of the foot in standing position.
- Foot motor performance was done with a single heel rise test.
- To evaluate gait spatiotemporal parameters “Powdered ground footprint method” was applied. Attendants were asked to walk normal on a three-meter powdered floor in a ten-meter area.
- Static balance measurements were measured with the “Biodex Portable Biosway” balance device. Participants were trained one minute for adaptation to the Biodex system. After 3 practice trials 3 test evaluations were performed in each measurement session.

Results:

HVA were reduced in all taping groups ($p < 0.05$). The Mulligan method of taping was the most effective method in reducing hallux valgus angle. However, a foot motor performance was not affected by taping in any of the groups ($p > 0.05$). Although a method of athletic taping increased step length and step width but reduced foot angle and cadency. The method of Mulligan taping increased cadency and reduced angle of the foot by ($p < 0.01$). Neither the Mulligan nor athletic taping methods did not affect the postural stability and fall risk ($p > 0.05$). Stability limits were increased in Mulligan taping group ($p < 0.05$).

4.2. Kinesio taping and stretching

Effects of Kinesio Taping and Stretching on Hallux Valgus Angle and Balance in Female Hallux Valgus Patients (Jung-Hyun Choi, 2017)

Aim of the research - To determine the effects of kinesio taping and stretching on changes and balance in patients with hallux valgus deformation.

Method: 24 females with diagnosed hallux valgus were divided into 3 groups: stretching (SG; n=8), taping (TG; n=8), and stretching with taping (STG; n=8). Kinesio Taping and elastic band were used for six weeks to reduce hallux valgus angle. The changes in the balance and hallux valgus angle were noticed. To determine changes in HV angle, radiographs were used to measure the degree of foot deformity. The Romberg Test was used to determine static balance ability and the Limits of Stability Test to determine dynamic balance ability.

Inclusion criteria:

- Hallux valgus angle greater than 15 degrees;
- Individuals without severe neurologic or musculoskeletal diseases;
- Participants who didn't had any operation for hallux valgus;
- Those lacking experience in exercises related to hallux valgus;
- Those not affected by other podiatric diseases.

Independent variables: elastic band-assisted stretching exercise and kinesio taping.

Dependent variables: measurement of hallux valgus angle and balance.

Application:

Stretching exercise using the elastic band exercise was performed 3 times a week for 6 weeks. An elastic band with the resistance huge enough to perform an exercise routine more than 15 times was selected to be used for stretching exercise. For 4 to 6 weeks, an elastic band with a higher level of elasticity than in the first exercise group was used. Warm-up and finishing exercises three sets of ankle

exercises 10 times each and learn the movement of toe abductors and adductors instead of ankle muscles. Agonist Contraction Exercise Participants were made to resist the resistance and induce contraction of the thumb abductors. The exercise was performed for 30 seconds with a 15 second break for a total of 10 sets that last for 7 minutes and 30 seconds. Hold-relax with Agonist Contraction Exercise was performed for a total of 10 sets that last for 7 min. and 30 sec. with maintenance of isometric contraction for 25 sec. and active stretching for 5 sec. and rest for 15 sec.

Results:

For 20 participants of 24 it significantly improved the body balance ability with hallux valgus deformity after use of elastic band and short foot exercises. Angle before and after intervention was significantly reduced in the stretching group from 15.57 ± 3.61 to 13.46 ± 4.12 , taping group from 15.02 ± 2.61 to 12.56 ± 2.80 , and stretching with taping group from 16.56 ± 4.01 to 14.00 ± 3.97 .

5. RESULTS ANALYSIS

The aim of the systematic literature analysis was to analyze the effect of physiotherapy for hallux valgus. The functions taken into the consideration were hallux valgus angle and gait patterns and balance. Five studies have been analyzed and they all matched the inclusion criteria: analyzed the effect of taping, stretching on gait correction and/ or angle reduction. All of the participants had a hallux valgus angle that is greater than 15 degrees.

The analyzed articles confirmed the significant effectiveness of different methods of physiotherapy applied for patients with hallux valgus in order to reduce the angle of hallux valgus. The first study compared two different taping methods - kinesio tape opposed to conventional tape on hallux valgus angle and intermetatarsal angle. Even though both taping techniques showed significant results in angle reduction kinesio taping group, right leg angle decreased from 28.33 to 16.40 degrees, left foot angle decreased from 29 to 18.73 degrees and the conventional group hallux valgus angle in the right foot decreased from 28.73 to 19.07, left foot, the hallux valgus angle decreased from 30.33 to 21.60, the results of kinesio taping group were more efficient. Moving further, another study presented kinesio tape (which was already found out as an effective treatment method alone) applied together with another method - joint mobilization. The study showed a significant decrease in the angle of the metatarsophalangeal joint from 20.51 ± 3.76 to 15.47 ± 4.3 . Another group that applied a combination of a few conservative methods for hallux valgus angle reduction was also effective - orthosis combined with toe-spread-out - reducing the angle from 18.33 ± 3.42 to 14.92 ± 3.36 .

It was noticed that the higher hallux valgus angle patients have - the higher the decrease of it is noticed when applying the right conservative treatment. In the first kinesio tape group participants had the highest hallux valgus angle and noticed the highest decrease in it (metatarsophalangeal joint angle decreased by av. $\sim 10 - 12$ degrees) when compared to kinesio tape and joint mobilization group (metatarsophalangeal joint angle decreased by av. ~ 5 degrees). Even though the second method was effective, the numbers were less impressive. The following study also compared kinesio tape and kinesio tape combined with joint mobilization method and it showed that both groups had a decrease in the angle, but the combination of kinesio tape and kinesio tape with joint mobilization was more effective. The third group, orthosis combined with toe-spread, provided an effective outcome, but the numbers couldn't be compared to the first, kinesio tape group, because mild angle has been already treated to a normal one

and the angle simply could not be decreased more (metatarsophalangeal joint angle decreased by av. ~3 degrees).

The angle reduction studies show that taping, exercising treatments are effective in reducing the hallux valgus angle. The analysis also suggests that kinesio tape alone can be applied when reducing the mild to moderate (20 - 40 degrees) HV angle and adding a combination of another conservative treatment to kinesio tape treatment, such as joint mobilization is very effective when treating mild angle (up to 30 degrees). When the HVA needs a slight reduction, the most conservative methods such as orthosis and toe-spread-out can be effective turning the HV angle from mild to normal. This analysis suggests that a patient that has a moderate HV can start the treatment using kinesio tape alone, then add a joint mobilization as a combination and finally apply the most conservative methods such as orthosis and toe-spread-out exercise for reaching the normal HV angle indicator.

Not all analyzed articles proved the positive effects of different methods of physiotherapy applied for patients with hallux valgus in order to improve gait patterns and balance. Rigid taping methods, Athletic and Mulligan taping, were applied and neither the Mulligan nor athletic taping methods affected the postural stability and fall risk of patients ($p > 0.05$). Stability limits were only slightly increased in Mulligan taping group ($p < 0.05$). When determining the effects of kinesio taping and stretching on changes and balance in patients with hallux valgus deformation, 20 participants of 24 significantly improved the body balance ability with hallux valgus deformity after use of elastic band and short foot exercises. The Romberg Test was used to determine static balance ability and the Limits of Stability Test to determine dynamic balance ability and showed effective results.

When comparing the available studies for hallux valgus angle reduction with studies for gait patterns and balance improvement, some clear differences appear - there are more studies that concentrate on HVA reduction than those analyzing gait pattern and balance abilities. When comparing the methods which were most efficient, it was found out that kinesio taping applied with exercising (joint mobilization for hallux valgus angle reduction and stretching for gait and balance improvement) was more efficient than kinesio tape alone in improving both of the factors - reducing angle and improving balance.

CONCLUSIONS

1. After systematic literature analysis it has been noticed that hallux valgus condition is significantly more frequent in women and tends to increase with age, turning the elderly women into the most common patients having hallux valgus condition;
2. Kinesio taping was found out to be the most effective taping method in the hallux valgus angle reduction;
3. The combinations of a few conservative treatment methods showed better results than in those studies groups where only one treatment method has been applied. The combination of kinesio tape and joint mobilization (for hallux valgus angle reduction) and kinesio tape and stretching (for gait and balance improvement) was more efficient than kinesio tape alone in both cases;
4. The physiotherapy treatments applied for hallux valgus angle reduction show greater results and offer wider variety of studies proving the efficiency, compared to the studies for gait pattern and balance - there are still not many studies published and the lack of such publications prevents the deeper analysis on the effectiveness. The appliance of kinesio tape was mainly concentrated on hallux valgus angle reduction, however only a few studies of this method appliance on gait and balance improvement have been published.

RECOMMENDATIONS

1. Patients with hallux valgus condition are recommended to wear shoes that are wide, has round and pointed toe box, are made from stretched fabric in order to slow down the progression, amount of deformity, even to prevent from the occurrence of Stage 1 HV;
2. Studies show, that for the most effective results in reducing angle of hallux valgus it is recommended to apply kinesio tape combining with another conservative treatment method such as joint mobilization or stretching;
3. For further studies it is recommended to concentrate on gait patterns and balance functions rather than other functions in order to widen the scope of benefits and effectiveness of physiotherapy for patients with hallux valgus condition.

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