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Effects of Iliotibial Band Flexibility and Tibial Torsion Angle on Improving Asymmetric Hallux Valgus Angle

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Abstract **Original Research Article**

Background: Hallux valgus is a progressive foot deformity in which first metatarsophalangeal joint is affected and causing functional disability and foot pain. ***Objective:*** To study the effects of iliotibial band flexibility and tibial torsion angle on improving asymmetric hallux valgus angle. ***Methods:*** The study was conducted on purposively selected 30 individuals from different physiotherapeutic clinics of Amritsar. The subjects were randomly allocated into two groups, such as, Group-A (those who received muscle strengthening for hallux valgus and iliotibial band stretching exercise programme) and Group-B (those who received only muscle strengthening exercise programme) for intervention for 5 days/per week for 4 weeks. The variables considered in the study were three anthropometric (i.e. height, weight, BMI), hallux valgus angle (HVA), intermetatarsal angle (IMA), tibial torsion angle (TTA) and iliotibial band flexibility (ITBF). ***Results:*** The results indicated that post-treatment individuals with asymmetric hallux valgus who were treated in Group-A had significantly ($p<0.021$-0.001) lower mean values in IMA-rt, IMA-lt, ITBF-rt and ITBF-lt than their pre-treatment counterparts. Whereas, the post-treatment individuals of Group-B has significantly ($p<0.002$-$p<0.001$) lower mean values in HVA-rt, IMA-rt and IMA-lt than their pre-treatment counterparts. ***Conclusion:*** In conclusion, it can be stated that both the treatment groups showed significant improvement in hallux valgus angle, though the individuals treated in Group-A with foot exercises, greater toe stretch, iliotibial band stretching and resistive and strengthening exercises showed higher improvement in iliotibial band flexibility than the individuals of Group-B who were treated with only foot exercises, resistive and strengthening exercises without iliotibial band flexibility.

Keywords: Iliotibial Band Flexibility, Tibial Torsion, Hallux Valgus Angle.

INTRODUCTION

Hallux valgus (HV) is a progressive subluxation of the first metatarsophalangeal joint [1] and causes functional disability and foot pain. It is involved in medial deviation of first metatarsal, lateral deviation of hallux i.e. with or without rotation of hallux and there is prominence, with or without medial soft tissue enlargement of first metatarsal head [2]. The use of high-heeled, narrow shoes is usually thought to cause the development of HV, but insufficient evidence supports unaccomodative shoes as the sole factor in the development of HV [3]. Poor footwear, however, is important in accelerating the progression of HV. It leads to functional disability, including pain, impaired gait patterns, poor balance, and falls in older adults [4]. It also leads to more than 200,000 surgeries every year among adults in the United States [5]. Consistently, the annual number of surgeries in Finland has been estimated at 78 operations per 100,000 persons [6].

Operative treatment has proven to be more efficient than conservative treatment with orthoses, and over 130 operative techniques have been published for HV correction [7]. All the generally known HV correction techniques include bunionectomy and/or distal soft-tissue procedures [8], but the rotational component of the deformity is commonly neglected. The eversion of the first metatarsal has been shown to increase sagittal stability of the first ray [9]. Thus, the rotational component of the HV deformity should be addressed during correction. HV has an impact on gait [10], as the HV deformity alters the kinematics of the first ray and reduces the plantar force generation of the first metatarsal and the hallux [11]. Even a mild HV may disrupt the propulsion function of the foot [12]. Various loading patterns have been reported relating to HV [13], and the reduced dynamic stability of the first ray affects also the lower limb. An internal rotation of the tibia compared to normal controls has been demonstrated in HV during the gait cycle [14].The literature related to the effects of iliotibial band flexibility and iibial torsion angle on improving asymmetric hallux valgus angle is scanty from the northern state of Punjab, India. Thus the present study was planned.

MATERIALS AND METHODS

Participants

The present study comprised of purposively selected 30 confirmed cases of asymmetric hallus valgus individuals (16 females and 14 males) aged 40-60 years from various Physiotherapy Clinics in and around Amritsar city, Punjab. The subjects were then randomly allocated into two groups for intervention for 5 days/per week for 4 weeks. Group-A and Group-B comprised of 15 subjects each with the protocol described in Table 1. The Age of the subjects was estimated from their date of birth. A written consent was obtained from all the subjects. The study was approved by the Institutional Ethical Committee (IEC).

Table-1: Exercise protocol for Group-A and B

Group-A	
Weeks	**Exercises**
1 week	Active or passive ROM exercises of ankle and MTP joint (10 repetation, 2 sets), Iliotibial Band stretching.
2 week	Big toe stretch and mobilization, iliotibial band stretching.
3 week	Toe grip strength, toe spread out exercises, iliotibial band stretching.
4 week	Resistive foot exercises, iliotibial band stretching.
Group B	
1 week	Active or passive ROM exercises of ankle and MTP joint (10 repetation, 2 sets).
2 week	Big toe stretch and mobilization
3 week	Toe grip strength, toe spread out exercises
4 week	Resistive foot exercises

Anthropometric Variables

Three anthropometric variables namely height, weight and BMI were measured from all the subjects using the standard techniques [15] and were measured in triplicate with the median value used as the criterion. Stadiometer (Holtain Ltd. Crymych, Dyfed, UK) was used for measuring standing height. Subjects were weighed in minimal light-weight clothing, bare foot, using standard weighing machine (Model DS-410, Seiko, Tokyo, Japan) to the nearest 0.1 kg. Body mass index (BMI) was calculated from height and weight as follows: BMI=weight (kg) / height^2 (m^2).

Measurement of Hallux Valgus Angle (HVA)

The HVA was measured on radiographs at the intersection between the long axis of the first metatarsal and the proximal phalanx. The axis of the first metatarsal was drawn through points that proximally and distally bisected the shaft of the bone, and the axis of the proximal phalanx was drawn through the midpoints of the proximal and articular surfaces (Fig. 1). Three measurements were made and the average was used in analysis [16].

Measurement of Intermetatarsal Angle (IMA)

The intermetatarsal angle was measured on radiographs between the long axes of the first and second metatarsals (Fig. 2). Three measurements were made and the average was used in analysis [17].

Measurement of Tibial Torsion Angle (TTA)

Each participant was asked to bend the knee through 90° and held the ankle in the neutral prone position. The examiner located the middle of the medial and lateral malleolus (in the anterior-posterior direction) at the level of the ankle, and marked the midpoint with a pen. To derive the axis passing through both malleoli, a line connecting the points of the medial and lateral bones was drawn on the sole of the heel. The stationary and movable arms of the goniometer was placed in line with this axis and on the longitudinal axis of the femur, respectively .The examiner recorded the angle between the two lines as the tibial torsion angle [18]. Each participant was instructed to remain relaxed during measurement to minimize rotation of the lower limb. Three measurements were made and used in analysis.

Measurement of Iliotibial Band Flexibility (ITBF)

We used the Ober's test to assess iliotibial band flexibility. Each participant was instructed to bend the lower leg through 90° to maintain the spine in a neutral position while lying on the side. The examiner stood behind the participant and placed a stabilizing hand on the upper iliac crest. The hip joint of the upper leg was placed in abduction and extension and the knee joint flexed through 90°. The examiner recorded the adduction angle with the upper leg pointing to the floor to a certain extent using enclinometer ensuring that the pelvis did not move [19].

Fig-1: Measurement of Hallux Valgus Angle

Fig-2: Measurement of Intermetatarsal Angle

STATISTICAL ANALYSIS

Data was analyzed using SPSS (Statistical Package for Social Science) version 20.0. Independent t-test was applied for all the variables between the individuals with hallux valgus treated in Group-A and Group-B and between pre- and post-treatment within each group. A 5% level of probability was used to indicate statistical significance.

RESULTS

Table 2 showed the descriptive statistics of anthropometric variables (age, height, weight and BMI) in hallux valgus individuals of Group-A and Group-B. The individuals of Group-A had higher mean values in height (169.53 cm), weight (70.33 kg) and lesser mean values in age (53.13 years) and BMI (24.40 kg/ m²) than their Group-B counterparts (165.13 cm, 66.73 kg, 54.26 years and 24.46 kg/ m² respectively). However, no significant difference was noted in any case.

The descriptive statistics of different variables between pre- and post-treatment individuals of Group-A were shown in Table 3. The post-treatment individuals of Group-A had higher mean value in TTA-rt (24.46^0) and lower mean values in HVA-rt (22.13^0), HVA-lt (17.46^0), IMA-rt (11.46^0), IMA-lt (11.80^0), TTA-lt (23.80^0), ITBF-rt (16.71^0), ITBF-lt (15.90^0) than their pre-treatment counterparts (24.06^0,25.60^0,19.40^0,15.13^0,24.46^0,23.13^0 and 22.40^0 respectively). However statistically significant differences ($p<0.021-0.001$) were noted in IMA-rt ($t=2.671$), IMA-lt ($t=2.446$), ITBF-rt ($t=5.157$) and ITBF-lt ($t=4.125$) between them.

Table-2: Descriptive statistics of anthropometric variables of Group-A and Group-B

Variables	Group-A		Group-B		t-value	p-value
	Mean	SD	Mean	SD		
Age (years)	53.13	6.49	54.26	4.87	0.541	0.593
Height (cm)	169.53	13.43	165.13	8.01	1.0879	0.285
Weight (kg)	70.03	11.07	66.73	6.73	1.o76	0.291
B.M.I kg/ m²	24.40	1.56	24.46	1.95	0.0093	0.927

Table 4 showed the descriptive statistics of different variables between pre- and post-treatment individuals of Group-B. The post-treatment individuals of Group-B had higher mean values in ITBF-rt (22.92^0) and lower mean values in HVA-rt (23.00^0), HVA-lt (22.20^0), IMA-rt (13.33^0), IMA-lt (13.26^0), TTA-rt (23.33^0), TTA-lt (22.93^0) and ITBF-lt (22.08^0) than their pre-treatment counterparts (20.13^0,27.26^0,25.53^0,18.46^0,17.46^0,23.46^0,22.93^0 and 22.59^0 respectively). However statistically significant differences ($p<0.002-0.001$) were noted in HVA-rt ($t=2.431$), IMA-rt ($t=3.617$) and IMA-lt ($t=3.672$) between them.

Table-3: Descriptive statistics of different variables between pre- and post-treatment individuals of Group-A

Variables	Pre-treatment		Post-treatment		t-value	p-value	% age decre./ incre.
	Mean	SD	Mean	SD			
HVA-rt (degree)	25.60	5.62	22.13	5.82	1.657	0.109	13.55%
HVA-lt (degree)	19.40	6.28	17.46	5.12	0.923	0.364	10.00%
IMA-rt (degree)	14.40	3.08	11.46	2.92	2.671	**<0.012**	20.41%
IMA-lt (degree)	15.13	4.42	11.80	2.88	2.446	**<0.021**	22.00%
TTA-rt (degree)	24.06	2.37	24.46	2.13	0.485	0.631	1.66%
TTA-lt (degree)	24.46	2.06	23.80	1.82	0.938	0.356	2.69%
ITBF-rt (degree)	-23.13	3.76	-16.71	3.00	5.157	**<0.001**	27.75%
ITBF-lt (degree)	-22.40	5.30	-15.90	3.03	4.125	**<0.001**	29.01%

HVA-rt= hallux valgus angle-right, HVA-lt= hallux valgus angle-left, IMA-rt= intermetatarsal angle-right, IMA-lt= intermetatarsal angle-left, TTA-rt= tibial torsion angle-right, TTA-lt= tibial torsion angle-left, ITBF-rt= iliotibial band flexibility-right, ITBF-lt= iliotibial band flexibility-left.

Table -4: Descriptive statistics of different variables between pre- and post-treatment individuals of Group-B

Variables	Pre-treatment		Post-treatment		t-value	p-value	% age decre./ incre.
	Mean	SD	Mean	SD			
HVA-rt (degree)	27.26	4.74	23.00	4.86	2.431	**<0.002**	15.6%
HVA-lt (degree)	25.53	5.16	22.20	4.57	1.872	0.072	13.04%
IMA-rt (degree)	18.46	4.27	13.33	3.45	3.617	**<0.001**	27.78%
IMA-lt (degree)	17.46	3.46	13.26	2.76	3.672	**<0.001**	24.05%
TTA-rt (degree)	23.46	2.72	23.33	2.41	0.142	0.888	0.55%
TTA-lt (degree)	22.93	2.86	22.93	2.98	0.001	1.000	0.01%
ITBF-rt (degree)	20.13	11.82	22.92	3.04	0.884	0.384	13.85%
ITBF-lt (degree)	22.59	4.16	22.08	4.00	0.342	0.735	2.25%

The descriptive statistics of different variables of post-treatment individuals of group-A and group-B were shown in Table 5. The individuals of Group-A had higher mean values in TTA-rt (24.46^0) and TTA-lt (23.80^0) and lower mean values in HVA-rt (22.13^0), HVA-lt (17.46^0), IMA-rt (11.46^0), IMA-lt (11.80^0), ITBF-rt (16.71^0), ITBF lt (15.90^0) than their Group-B counterparts (23.33^0, 22.93^0, 23.00^0, 22.20^0, 13.33^0, 13.26^0, 22.92^0 and 22.08^0 respectively). However significant differences (p<0.012-0.001) were noted in HVA-lt (t=2.670), ITBF-rt (t=5.612) and ITBF-lt (t=4.767) between them.

Table-5: Descriptive statistics of different variables of post-treatment individuals of group-A and Group-B

Variables	Group-A		Group-B		t-value	p-value
	Mean	SD	Mean	SD		
HVA-rt (degree)	22.13	5.82	23.00	4.86	0.442	0.662
HVA-lt (degree)	17.46	5.12	22.20	4.57	2.670	**<0.012**
IMA-rt (degree)	11.46	2.92	13.33	3.45	1.597	0.122
IMA-lt (degree)	11.80	2.88	13.26	2.76	1.422	0.166
TTA-rt (degree)	24.46	2.13	23.33	2.41	1.364	0.184
TTA-lt (degree)	23.80	1.82	22.93	2.98	0.959	0.346
ITBF-rt (degree)	16.71	3.00	22.92	3.04	5.612	**<0.001**
ITBF-lt (degree)	15.90	3.03	22.08	4.00	4.767	**<0.001**

DISCUSSION

Hallux valgus is bony bumps that are formed on joint at the base of big toe. It occurs when big toe pushes against next toe. It is highly prevalent and progressive musculoskeletal foot deformity. It affects one in three elderly adults over 65 years of age; nearly one in four adults aged 18-65 years and 8% of children [20].

The findings of the present study stated that post-treatment individuals with asymmetric hallux valgus who were treated in Group-A had significantly (p<0.021-0.001) lower mean values in IMA-rt, IMA-lt, ITBF-rt and ITBF-lt than their pre-treatment counterparts. These differences were due to toe-spread out exercises which decreased the hallux valgus angle, big toe stretch which lengthened the tissue surrounding the big toe and increased the range of motion. Strengthening exercises prevented the hallux valgus and corrected the deformity. Resistive exercises increased the strength and rate of muscle force development. Iliotibial band stretching exercises increased the flexibility of iliotibial band. Kin *et al*. [21] showed that hallux valgus angle was associated with iliotibial band flexibility. Therefore, stretching of iliotibial band should be considered during rehabilitation of the hallux valgus. Abdalbary [22] reported that Bunion stretch increased the range of motion of greater toe and lengthened the surrounding tissue which helped in decrease the hallux valgus deformity. Again, Kim *et al.* [23, 24] opined that strengthening of the adductor halluces and abductor halluces could prevent a hallux valgus and could be helpful to correct the deformity. Fraissler *et al.* [25] showed that non-operative management could correct the hallux valgus deformity, whereas successful surgery improved functional outcome.

The findings of the present study stated that the post-treatment individuals of Group-B has significantly ($p<0.002$-$p<0.001$) lower mean values in HVA-rt, IMA-rt and IMA-lt than their pre-treatment counterparts. These differences were due to ankle range of motion exercises which strengthened the ankle. The toe spread out exercises decreased the hallux valgus angle and inter-metatarsal angle. The resistive exercise training increased the strength of muscles which helped in correcting the deformity. Kim *et al.* [23] showed that toe-spread-out exercises decreased hallux valgus angle and recommended for patients with mild to moderate hallux valgus. Ward *et al.* [26] reported that the treatment of progressive first metatarsophalangeal hallux valgus deformity were resistive exercise training which increased the strength and rate of muscle force development. Bayar *et al.* [27] opined that the 8-wek period of exercises reduced pain and improved patient's ability to walk. In contrary, Walcher *et al.* [28] showed that non-operative treatment of hallux valgus could not correct the deformity. However, insole and physiotherapy in combination with good footwear could help in controlling symptoms. Kim *et al.* [21] also reported that the hallux valgus angle decreased the flexibility of iliotibial band. Therefore, stretching exercises should be involved in hallux valgus rehabilitation.

CONCLUSION

The findings of the present study revealed that both treatment groups showed significant improvement but the individuals treated in Group-A with foot exercises, greater toe stretch, iliotibial band stretching and resistive and strengthening exercises showed higher improvement in iliotibial band flexibility than the individuals of Group-B who were treated with only foot exercises, resistive and strengthening exercises without iliotibial band flexibility. Thus, the results of this study supported the previous studies which studied the effect of hallux valgus angle on tibial torsion angle and iliotibial band flexibility, in which they concluded that the hallux valgus angle did not differ but the iliotibial band was less flexible on the greater hallux valgus side. So, that iliotibial band flexibility exercises should be considered during the hallux valgus rehabilitation.

REFERENCES

1. Coughlin R, Norn S. How to examine a foot and what to do with Bunion. The Foot and Ankle Orthopaedics. 1996; 23(3):281-93.
2. Crista J, Robinson D. Hallux valgus: Background, anatomy and pathophysiology. Foot and Ankle Surgery. 2019; 1(12): 1-17.
3. Trnka HJ, Krenn S, Schuh R. Minimally invasive hallux valgus surgery: A critical review of the evidence. International Orthopaedics. 2013; 37 (9):1731-5.
4. Nix S, Smith M, Vicenzino B. Prevalence of hallux valgus in the general population: A systematic review and meta-analysis. Journal of Foot and Ankle Research. 2010; 3(21):106-9.
5. Coughlin R, Michael J. Juvenile Hallux valgus: Etiology and treatment. Foot Ankle International. 1995; 16(11): 682-97.
6. Torkki M, Malmivaara A, Seitsalo S. Surgery vs Orthosis vs Watchful waiting for hallux valgus: A randomized controlled trial. JAMA. 2010; 285(19): 2474-80.
7. Robinson A, Limbers JP. Modern concepts in treatment of hallux valgus. The Journal of Bone and Joint Surgery, 2005; (8):1038-45.
8. Easley ME, Tmka HJ. Current concepts review: Hallux valgus Part 1: Pathomechanics, clinical assessment, and non-operative management. Foot Ankle Int, 2007; 28(5):654-9.
9. Perez B, Lopez D. Geometry of the proximal phalanx of hallux and first metatarsal bone to predict Hallux aducto Valgus: A radiological study. Plos One. 2008; 11(11): 166-97.
10. Smith D, Vicenzino T, Nix E. Gait parameters associated with hallux valgus: A systematic review. Journal foot and Ankle Research. 2013; 6(9): 1146-69.
11. Koller U, Willegger RW. Plantar pressure characterstics in Hallux valgus feet. Journal of Orthopaedic Research. 2014; 32(12): 1688-93.
12. Cancilleri F, Marinozzi A, Martinelli N, Ippolito M, Spiezia F, Ronconi P. Comparison of plantar pressure, clinical, and radiological changes of the forefoot after biplanar Austin osteotomy and triplanar Boc osteotomy in patients with mild hallux valgus. Foot and Ankle International. 2008; 29(8):817-24.
13. Nix SE, Vicenzino BT, Collins NJ, Smith MD. Characteristics of foot structure and footwear associated with hallux valgus: A systematic review. Osteoarthritis Cartilage; 2012; 20(10):1059-74.
14. Canseco K, Rankine L, Long JT, Smedberg T. Motion of the multisegmental foot Hallux Valgus. Foot & Ankle International. 2010; 31(2): 146-52.
15. Lohmann TG, Roche AF, Martorell R. Anthropometric Standardization Reference Manual.Champaign, IL: Human Kinetics Books; 1988.
16. Glasoe W, Nuckley D, Ludewig P. Hallux valgus and the first metatarsal arch segment: A theoretical

biomechanical perspective. Physical Therapy. 2010; 90(1):110–20.

17. Smith B, Andrew J, Vaida J, Daniel J. Hallux valgus. American Orthopaedic Foot and Ankle Society. 2010; 42(2):1-12.
18. Milner CE, Soames RW. A comparison of four in vivo methods of measuring tibial torsion. Journal of Anatomy. 1998; 193(1):139-44.
19. Reese N, Bandy W. Use of an inclinometer to measure flexibility of the iliotibial band using the Ober test and modified Ober test: Differences in magnitude and reliability of measurements. Journal of Orthopaedics and Sports Physical Therapy. 2003; 6(33):326-30.
20. Vicenzino BT, Hurn S, Smith D. Non-surgical treatment of hallux valgus: A current practice survey of Australian podiatrists. Journal of Foot and Ankle Research. 2016; 12(9): 213-26.
21. Kim S, You KJ, Jung DF. Between side comparison of iliotibial band flexibility and the tibial torsion angle in subjects with an asymmetric hallux valgus angle. Journal of KEMA. 2018; 1(2):11-5.
22. Abdalbary SA. Foot mobilization and exercise program combined with toe-separator improves outcomes in women with moderate hallux valgus at 1-year follow-up: A randomized clinical trial. Am Podiatr Med Assoc. 2018; 108(6): 478-86.
23. Kim M, Kwon O, Kim S. and Jung D. Comparison of muscle activities of abductor hallucis and adductor hallucis between the short foot and toe-spread-out exercises in subjects with mild hallux valgus. Journal of Back and Musculoskeletal Rehabilitation. 2013; 26(2):163-8.
24. Kim M, Weon J, Cynn H, Jung D, Kwon O. Effect of toe-spread-out exercises on hallux valgus angle cross-sectional area of abductor halluces muscle in subjects with hallux valgus. Journal of Physical Therapy Science. 2014; 4(27): 1019-22.
25. Fraissler L, Konrads C, Hoberg M, Walcher M, Rudert M. Treatment of hallux valgus deformity. EFORT Open Rev Journal. 2016; 1(8): 295-302.
26. Ward M, Glasoe W. Treatment of progressive first metatarsophalanged hallux valgus deformity: A biomechanially based muscle-strengthening approach. Journal of Orthopaedics and Sports Physical Therapy. 2016; 46(7): 596-605.
27. Bayar B, Erel S, Engin I. The effects of taping and foot exercises on patients with hallux valgus: A preliminary study. Turkish Journal Medical Science. 2011; 41(3): 403-9.
28. Walcher M, Fraissler L, Konrads C. Treatment of hallux valgus deformity. Bone and Joint Publishing. 2016; 8(1): 295-302.