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Immediate effect of dynamic stretching with and without floss band on hamstring flexibility in futsal players: A pilot study

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ABSTRACT

Objectives: The objective of this study was to assess the immediate impact of dynamic stretching with and without floss band on hamstring flexibility in futsal players.

Methods: Fifty-four players were included and randomly divided into tissue flossing and non-tissue flossing groups. Both groups performed dynamic stretching of the hamstring muscle, three sets of 15 repetitions. Active knee extension (AKE), straight leg raise (SLR), and sit-and-reach tests were conducted before and after the intervention. Blood samples were also drawn pre- and post-intervention to determine serum creatine kinase (CK) and lactate dehydrogenase (LDH) for recording muscle damage.

Results: On comparing the results of both groups, the tissue flossing group had significantly increased scores (left leg $P = 0.005$, right leg $P = 0.007$) for the AKE and sit-and-reach tests ($P = 0.017$). The two groups had no significant SLR, CK, or LDH disparity ($P > 0.05$). On the other hand, within-group comparisons showed a significant disparity ($P < 0.05$) between all variables in both groups.

Conclusion: The present study revealed that dynamic stretching with and without a floss band improved hamstring flexibility by increasing AKE, SLR, and sit-and-reach tests; however, results were significantly improved with a floss band. Compared to dynamic stretching without flossing, flossing resulted in better improvement of AKE and sit-and-reach test scores, while serum CK and LDH remained the same for both groups.

Keywords: Dynamic stretching, Floss band, Futsal, Hamstrings, Tissue flossing

INTRODUCTION

Futsal is a sporadic, high-intensity sport that places significant physical, technical, and tactical demands on the participants.[1] In addition, the good futsal performance of the players is determined by some physical qualities such as the ability to sprint repeatedly, sudden change of speed or direction, and tackle and turn.[2] The growing popularity of futsal presents a challenge and a chance for sports physiotherapists to contribute to the growth of this sport.[3] Athletes

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are subjected to muscle wear that can have major negative consequences on their bodies and perhaps result in injuries that could temporarily prevent them from participating in sports.[4] Most injuries (86.5%) were to the lower limbs.[5] The fact that the lower extremity is under more stress in this sport may be to blame for the imbalance between the body parts.

One important factor of hamstring efficacy is flexibility. Futsal players should theoretically have good hamstring flexibility to improve performance and reduce muscle strain and knee injuries. However, it has been reported that futsal players frequently lack flexibility in their hamstrings.[6] Effective conditioning for flexibility preserves futsal players' performance spikes and reduces the probability of degenerative aging-related changes. Flexibility should be a core area for improvement for any sportsperson as it comprises one of the core components of overall wellness that are taught in every health science profession.[7] The flexibility of the hamstring muscle improved the athletic performance of sprinters and vertical jumpers by increasing speed and agility.[8,9]

In clinical settings, hamstring muscle length can be determined indirectly by measuring hip range of motion (ROM) using a goniometer by performing the passive straight leg raise (SLR) or active knee extension (AKE) tests.[10] Another test that is used to measure flexibility is the sit-and-reach test. The hamstring and lower back flexibility can be examined using the sit-and-reach test. A crucial component of any physical preparation for sports is the use of stretching exercises to improve flexibility. Stretching can help to become more flexible, which may reduce the likelihood of musculotendinous injuries, lessen and ease muscular soreness, and improve overall athletic performance.[11] There are three main types of stretching: static, dynamic, and stretching before contraction.[12]

Dynamic stretching is divided into two categories: Active stretching and Ballistic stretching. While ballistic stretching involves quick, alternating movements or "bouncing" near the end of a limb's ROM, active stretching demands the repeated motion of an extremity through its available ROM. It is believed that stretching before exercise as part of a warm-up reduces passive stiffness and increases the ROM. For athletes, such as basketball players or sprinters, who must undertake running or leaping maneuvers as part of their sport, dynamic stretching is a preferable option.[13] All stretching methods help improve flexibility, but dynamic stretching is considered superior as it also improves athletic performance. According to theory, dynamic stretching is more physiologically and functionally suitable for preparing for sporting activities. As a result, research on both types of stretching has rapidly increased, particularly with studies of specific elements of athletic performance, including force, power, and sprinting speed.[14] A novel technique called flossing tissue – using a floss band device – has been devised to improve the ROM and flexibility. The Voodoo Floss Band, a 7' × 2" band, is a recently introduced tool in the clinical setting. It is now also used by some athletic trainers and therapists for treatment and rehabilitation. To improve the efficacy of the treatment, it has also been advised to perform movements of the muscles or joints that have been flossed to their maximum ROM.[15]

Of note, previously, no study has addressed the effectiveness of the floss band technique on the flexibility of hamstring muscles with dynamic stretching yet; hence, to establish whether the flossing technique with dynamic stretching can improve hamstring flexibility, this research study was conducted. Furthermore, the comparison between the effect of dynamic stretching with and without floss band has not been studied yet. Moreover, very few studies have been conducted regarding floss bands' effectiveness in athletic settings, especially with futsal players. This study aimed to assess the immediate impact of dynamic stretching with and without floss band on hamstring flexibility in futsal players. The flossing technique might improve ROM and performance; however, its effect on muscle physiology has not been studied in detail. The effect of the floss band on muscle damage serum markers is vital in this regard, and it was also studied in this study. This study's findings will help physiotherapists and sports therapists properly comprehend and plan or pick better treatment techniques for enhancing hamstring muscular flexibility in futsal players.

MATERIALS AND METHODS

The study design was a randomized controlled pilot study (Trial ID: NCT06101602). The study setting used the Pakistan Soccer Futsal Federation, Islamabad. The duration of the study was 12 months. The sample size was calculated using post-intervention hamstring ROM values of two groups following floss-band and elastic bandage stretching methods. The sample size was 54, divided into two groups of 27 using the lottery method. A non-probability convenience sampling technique was used for this study.

The study inclusion criteria were male and female national-level futsal players aged 17–35 who had been active for the previous three months. The study's exclusion criteria include hamstring strain in the past three months and any ligament or skeletal injury in the previous six months. Floss band, goniometer, sit-and-reach test, serum creatine kinase (CK) levels, and serum lactate dehydrogenase (LDH) levels tools were used for the "Pre" and post-assessment of outcome measures of futsal athletes during the study.

Floss bands are mobility performance tools that help to reduce pain, improve joint ROM function, and improve performance. They come in a variety of colors with 0.06" Thick ×2" Width ×7" long and heavy strength levels. Applying the tissue flossing band under tension causes compression and venous constriction. After removing the compression, the re-perfusion of the muscle tissue theoretically brings about favorable changes in terms of flexibility. A goniometer is an instrument that is utilized to measure the angle of the joint or joint ROM. The universal goniometer is a reliable (intra-class correlation coefficient [ICC] = 0.92) and valid (r = 0.97, ICC = 0.98) tool to determine the joint ROM. The sit-and-reach test is a flexibility test used to check the flexibility of the hamstrings and lower back. This test is a reliable (ICC = 0.98) and valid (0.90) tool for measuring hamstring flexibility. CK is necessary for muscle cells to function, while human blood contains minor amounts of CK, elevated levels signify muscle damage. The material that accumulates after skeletal muscle damage is called CK-MM. This test to assess muscle injury is reliable (r = 0.87) and valid (r = 0.58). The enzyme LDH turns sugar into energy. The blood level of this enzyme rises in response to tissue injury. This test to assess muscle injury is valid (r = 0.98).

Players were selected according to the selection criteria in the data collection procedure. Consent was obtained before the procedure started, and players were randomly divided into two groups. Group A received the intervention with a floss band, while group B was without a floss band. In the pre-intervention assessment, players of both groups were assessed for joint ROM using the SLR and AKE tests, and hamstring flexibility was assessed using the sit-and-reach test. Blood samples were also drawn to test for serum CK and LDH in blood. During the intervention, group A performed leg swings with the floss band wrapped around the thigh, while group B performed it without the floss band. In the post-intervention assessment, players were again assessed for ROM using a goniometer and hamstring flexibility by performing a sit-and-reach test. Blood samples were collected again to examine the serum CK and LDH levels and inspect for muscle damage.

The intervention protocol consisted of a dynamic stretch specifically for the hamstring muscles. Both groups, one

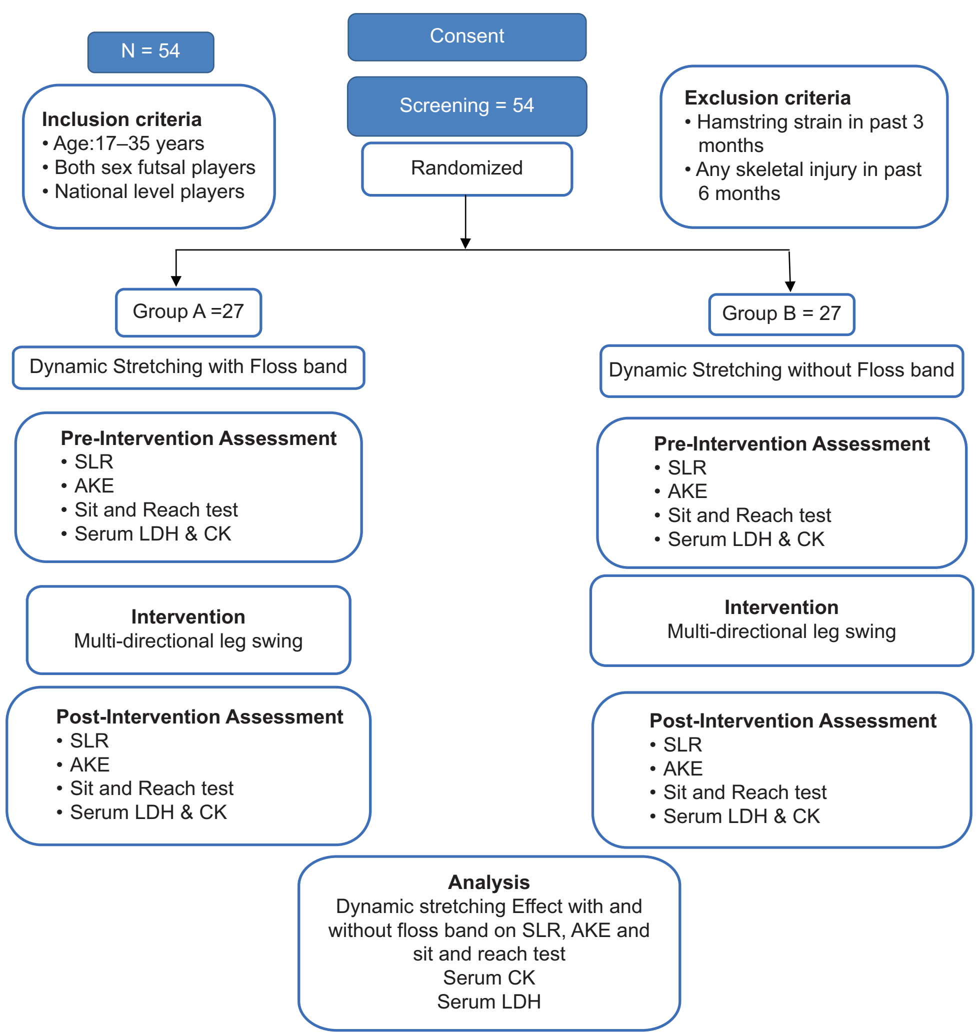

Figure 1: Consolidated standards of reporting trials. AKE: Active knee extension, SLR: Straight leg raise, CK: Creatine kinase, LDH: Lactate dehydrogenase.

using a floss band and the other without a floss band, performed the intervention in three sets of 15 repetitions (2-s stretch × 15 Rep) with 30 s of rest between each set. This protocol was performed in a 10–20-min session. No warm-up was performed by any subject to eliminate any potential interaction between warm-up and stretching. The Figure 1 provides the CONSORT flow diagram of the study.

Statistical analysis

Data was analyzed using IBM Statistical Package for the Social Sciences version 26th. The Shapiro–Wilk test was used to determine whether the data was normal. Four of the fourteen variables exhibited skewed values (>0.05). Parametric tests were used for data with normal values (<0.05 *P*-value), whereas non-parametric tests were used for data with skewed values. A paired *t*-test was employed for parametric tests to compare values within the group, and the Wilcoxon signed-rank test was utilized for non-parametric tests. An independent *t*-test and a Mann–Whitney U-test were employed to compare the outcomes between the groups.

RESULTS

The mean age of players in group A was 23.7 ± 2.9 and of group B was 23.3 ± 3.33, and the total body mass index of the players of group A was 21.8 ± 1.65 and of group B was 5.63 ± 0.24. The mean height of groups A and B players was 5.59 ± 0.25 and 5.63 ± 0.24, respectively. The mean weight of groups A and B players was 62.6 ± 7.34 and 62.3 ± 9.24, respectively [Table 1].

Within-groups comparison

For comparison within the group between pre- and post-intervention, a paired sample *t*-test was used for normal valued data, which showed a significant disparity within-group comparison. For skewed valued data, the Wilcoxon signed-rank test was applied; the results were statistically significant for the CK enzyme (0.000), while LDH (0.202) showed no significant disparity. A comparison of data within group B showed a significant difference (0.000) in all variables. The left and right leg SLR showed a significant disparity between pre-and post-intervention, AKE, and sit-and-reach tests, with $P < 0.05$. The level of serum LDH and CK was also increased [Tables 2 and 3].

Between-group comparison

In between-group analyses at the post-intervention phase, significant disparity was seen in most variables. SLR and AKE were used to determine the ROM, and the hamstring flexibility sit-and-reach test was used. SLR of the right (0.391) and left (0.255) legs showed no significant difference. AKE test for the left (0.005) and right leg (0.007) and the sit-and-reach test for hamstring flexibility (0.017) showed

Table 1: The demographic data of study participants.

Variables	Mean±SD	
	Group-A	Group-B
Age	23.7±2.9	23.3±3.33
Height	5.59±0.25	5.63±0.24
Weight	62.6±7.34	62.3±9.24
BMI	21.8±1.65	21.7±1.97

BMI: Body mass index, SD: Standard deviation

Table 2: Within-group comparison (parametric analysis).

Variables	Mean±SD		*P*-value
	Pre	Post	
Group A			
SLR (Lt)	53.24±6.91	61.51±6.89	0.000
SLR (Rt)	53.10±6.82	61.68±6.60	0.000
AKE (Lt)	140.37±4.47	149.75±4.78	0.000
AKE (Rt)	139.48±4.45	149.58±4.79	0.000
Sit-and-Reach	15.36±3.03	19.92±3.05	0.000
Group B			
SLR (Lt)	54.16±7.81	59.24±7.65	0.000
SLR (Rt)	53.92±7.25	60.04±7.42	0.000
AKE (Lt)	141.36±3.82	145.84±5.02	0.000
AKE (Rt)	140.52±3.60	145.80±5.15	0.000
Sit-and-reach	15.32±2.98	17.91±2.89	0.000

SD: Standard deviation, SLR: Straight leg raise, AKE: Active knee extension, Rt: Right, Lt: Left

Table 3: Within-group comparison (Non-parametric analysis).

Variables	Median (IQR)		*P*-value
	Pre	Post	
Group A			
CK	249 (273)	257 (277)	0.000
LDH	289 (78)	291 (86.5)	0.202
Group B			
CK	104 (260)	114 (257)	0.000
LDH	275 (137.5)	287 (127)	0.001

CK: Creatine kinase, LDH: Lactate dehydrogenase, IQR: Interquartile range

a significant disparity between groups. The sit-and-reach flexibility test for group A improved more than group B [Table 4]. To assess the muscle damage, level of CK and LDH enzymes of both groups were analyzed. No significant disparity was seen in CK (0.306) and LDH (0.742) levels between the experimental and control groups [Table 5].

DISCUSSION

The experimental group showed a significant increase in the AKE and sit-and-reach test than the control group.

Table 4: Between group's comparison (Parametric analysis).

Variables	Mean±SD		*P*-value
	Group-A	Group-B	
SLR (Lt)	61.51±6.89	59.24±7.65	0.255
SLR (Rt)	61.68±6.60	60.04±7.42	0.391
AKE (Rt)	149.58±4.79	145.80±5.15	0.007
AKE (Lt)	149.75±4.78	145.84±5.02	0.005
Sit-and-reach	19.92±3.05	17.91±2.89	0.017

SD: Standard deviation, SLR: Straight leg raise, AKE: Active knee extension, Rt: Right, Lt: Left

Table 5: Between groups' comparison (Non-parametric analysis).

Variables	Median (IQR)		*P*-value
	Group-A	Group-B	
CK	257 (277)	114 (257)	0.306
LDH	291 (86.5)	287 (127)	0.742

CK: Creatine kinase, LDH: Lactate dehydrogenase, IQR: Interquartile range

In addition, it does not improve SLR and serum CK and LDH compared to the control group. The primary outcome of this study was the flexibility of the hamstring muscles. Fascia shearing and muscle blood vessel blockage are potential effects of floss bands on muscle exertion and flexibility. In addition, fascia transitions from a solid gel-like state to a fluid solution-like state due to decreased fascial viscoelasticity when heat or mechanical pressure is applied (thixotropy).[16] Due to its close contact with the skin, a floss band covers the leg in all directions while exerting significant mechanical pressure on the muscles. As a result of increased intramuscular pressure and the ensuing muscle contraction under compression, muscle compression maintains heat, which may result in heat production and decreased fascial viscoelasticity. As a result, heat or mechanical pressure induced by flossing may allow muscles to easily lengthen by reducing fascial viscoelasticity.[17]

In particular, flossing improved the AKE and sit-and-reach test ($P < 0.05$). Several studies supported the current results for AKE, including a randomized crossover trial, which was done to study the acute effect of tissue flossing on neuromuscular performance of upper thigh muscle function.[18] They reported a significant increase in the experimental group's AKE value and hamstring function. Another similar study was done by Kitsuksan and Earde,[19] who studied the effect of tissue flossing during isolated stretching on hamstring flexibility and concluded that the sit-and-reach test and AKE were significantly improved after tissue flossing as compared to the control group.

SLR showed no significant disparity across both groups. Vogrin studied the acute effect of tissue flossing and reached similar results: SLR was unaffected regardless of the intervention.[18] This difference between the present study and the previous literature might be due to different intervention techniques and timing between this study and previous research. The secondary outcome of this study was to analyze the muscle damage caused using a floss band with dynamic stretching. No previous study assessed the muscle damage caused by tissue flossing. Serum CK and LDH were evaluated to assess muscle damage. Cengiz *et al*. studied the acute effect of dynamic and static stretching on anaerobic power and muscle damage in wrestlers and concluded that CK values increased with dynamic stretching.[20]

The present study's main clinical conclusion is that flossing the hamstring muscles with dynamic stretching may be useful for preventing injury and improving physical performance. Given this, plus the current findings that flossing increased hamstring muscular flexibility, flossing of the hamstring muscles may help reduce hamstring strain injuries in sports. The strengths of our study are the robust randomization process, a well-defined intervention protocol, and validated outcome measures such as AKE, SLR, and sit-and-reach tests.

Limitations

This study has several limitations. First, it did not focus on the long-term impacts of tissue flossing; instead, it focused more on immediate effects. Second, this study included futsal players who were healthy and had not been injured in the past six months.

CONCLUSION

The present study revealed that dynamic stretching with and without a floss band improved hamstring flexibility by increasing AKE, SLR, and the sit-and-reach test. However, with a floss band, results were significantly improved. Compared to dynamic stretching without flossing, flossing improved AKE and sit-and-reach test scores better, while serum CK and LDH remained the same for both groups.

RECOMMENDATIONS

Future research should be done to study the long-term effects. More studies should be done on athletes with muscle or ligament injuries to see what role tissue flossing plays in rehabilitation.

AUTHORS' CONTRIBUTIONS

SFZ contributed to study conception and data collection, NS contributed to data collection, MFA contributed to data interpretation, and DOSMG contributed to critical analysis of the manuscript for important intellectual points, proofreading and revision of the manuscript. All authors have critically reviewed and approved the final draft and are responsible for the manuscript's content and similarity index.

ETHICAL APPROVAL

The study received approval from the Institutional Review Board of "Riphah College of Rehabilitation & Allied Health Sciences", RCRS/REC 01217, Dated: January 12, 2022.

DECLARATION OF PARTICIPANT CONSENT

The authors certify that they have obtained all appropriate participant consent forms. In the form, the participants have given their consent for their images and other clinical information to be reported in the journal. The participants understand that their names and initials will not be published, and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

USE OF ARTIFICIAL INTELLIGENCE (AI)-ASSISTED TECHNOLOGY FOR MANUSCRIPT PREPARATION

The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

CONFLICTS OF INTEREST

There are no conflicting relationships or activities.

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