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COMPARATIVE EFFECTS OF CLAMSHELL TECHNIQUE WITH ELECTRICAL MUSCLE STIMULATION VERSUS CONSERVATIVE TREATMENT IN ILIOTIBIAL BAND TIGHTNESS FOR PAIN AND FUNCTION

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Abstract

Background: Iliotibial band syndrome (ITBS) is caused by repetitive activities that affect the gluteus Medius strength, Tensor fascia latea, and Iliotibial band tensions. Exercises and clamshell exercises help to improve muscular strength and imbalance.

Objective: The objective is to determine the effects of the Clamshell technique with electrical muscle stimulation in improving pain and function among Iliotibial band tightness.

Material and methods: The randomized controlled trial was conducted in the Teaching hospital of the University of Lahore. The sixty-two male and female patients 45-65 years of age were selected, and diagnosed with ITBS having lateral knee pain. Patients randomly assigned to Group A received the Clamshell technique with electrical muscle Stimulation while Group B received conservative treatment. Numeric pain Rating scale, Lower Extremity Functional scale, Iliotibial band length, and Goniometer were used for the assessment of pain, functional status, length of IT band, and Range of motion were the main outcome measures. SPSS was used for the statistical analysis having p-value <0.05.

Results: The results showed, in group A had 16(51.6%) females and 15(48.4%) males with while group B had 15(48.4%) females and 16(51.6%) males having mean age of 54±5.9 and 55.38 ± 6.5 respectively. Within-group analysis confirmed NPRS and LEFS highly improved by Clamshell exercises while non-significant results were observed on comparative analysis in group B with pvalue >0.05.

Conclusion: The study concluded clamshell technique with electrical muscle stimulation and conservative treatment including stretching and strengthening both produce promising results in improving pain and functional status among iliotibial band tightness.

Keywords: Clamshell, Iliotibial Band Syndrome, Hip Abductors, Lateral Leg Pain, EMS

Introduction

Iliotibial band syndrome (ITBS) is a common non-traumatic overuse knee injury that usually presents with pain and/or tenderness on palpation of the lateral aspect of the knee, superior to the joint line and inferior to the lateral femoral epicondyle (1). The iliotibial band (ITB) is a thick band of connective tissue running from the lateral side of the hips and thigh to and knee and shinbone (2). Being 22% prevalent in runners(3), it is referred to as "runner's knee" and is commonly caused by activities where the knee is repeatedly bent, such as running, cycling, hiking, and walking long distances (4). The prevalence of ITBS in female runners is quite variable, ranging from 1.6% to 14%. However, the reported incidence of ITBS has almost doubled from 1981 to 2000, rising from 4.3% to 8.4% among the population of patients presenting with running injuries (5).

The peak hip adduction, peak hip abductor moment, peak contralateral pelvic drop, shape and structure of the hip and knee joints (6, 7), training errors, muscle weakness or imbalance, inappropriate footwear, excessive hill running, leg length discrepancies, and running on hard and uneven surfaces, rolling the foot while running, naturally tight or wide IT band, flattening foot or pronating when running, and insufficient stretching are the major biomechanical and anatomical IT band tightness factors (8, 9).

The compression of the innervated tissues beneath the iliotibial band (ITB)along with the friction of the underlying bursa and IT band caused knee inflammation (10). However, sometimes if the IT band is too tight, bending the knee creates friction, leading to swelling and pain (11, 12). Pain and tenderness on the lateral aspect of the thigh, by applying pressure causes pain, and assessment of hip and knee ranges on lying, standing on one leg or squatting helps to evaluate the patient's severity (13). The tightness of the IT band was further analyzed by the confirmation tests including the Ober test and Noble test. The Ober test, a gold standard diagnostic test, assesses the tightness in the tensor fasciae latae (TFL) and iliotibial band (ITB) (14).

Ober's test was performed in a side-lying position, with the lower leg flexed at the hip and knee for stability. By passively the upper leg and bringing it into slight extension followed by slowly lowered down to the table. If the upper leg stays in the air and does not fall, the test is considered positive for ITB tightness(15). Another diagnostic test, the Noble test, is performed by compressing the iliotibial band (ITB) 2 centimeters proximal to the lateral femoral condyle while the patient is in a supine position with both their affected side knee and hip flexed to 90 degrees (16). The active painful extension of the knee and hip during sustained compression leads to the confirmation of ITBS (17).

Physiotherapy including corrective exercises, strengthening exercises for the gluteal muscles and hip flexors, manual therapy, neuromuscular re-education, static stretching, active recovery strategies, footwear and shoe changes, and cross-training helps in managing ITBS(18). The correction and strengthening of weak or malfunctioning lateral gluteal muscles help improve muscle balance and reduce the strain on the iliotibial band (19). Additionally, Manual therapy including muscle energy techniques(20), foam rolling and self-massage(21), and Wearing appropriate footwear and changing shoes(22) helps to alleviate pain, and compensatory muscular action.

Recently, the Clamshell technique manually and with a resistance band helps in increasing hip strength and stability of gluteus medius and hip abductors (23)and alleviates IT band tightness and pain (24). Foch et al (2023) stated female runners with current ITBS exhibited smaller peak hip internal rotation angles and lower isometric hip abductor strength compared to controls (22). Lime E et al. (2023) proposed that effective Pilates clamshell exercise helps in managing Gluteus medius activation and motor impairment among patients (25). Moreover, SG et al (2019) supported that the combination of modified clamshell exercises played a significant role in enhancing gluteus medius and quadratus

lumborumativity and strength with reducing the overactivity of anterior hip flexor contraction in IT band patients(24).
Ahmadi P et al (2018) supported resisted Clamshell exercises in combination with hip extension, and bridging was highly effective in stimulating Gluteus medius ultimately reducing the tension in the Tensor fascia latea and IT band(27). Most of studies provide the in-depth of Clamshell effectiveness with other techniques without the combination of electrical muscle stimulation (EMS).
Therefore, the present study focused on the effect of clamshell techniques with electrical muscle stimulation in improving pain and functional status among the iliotibial band tightness

Methodology:
The single-blinded randomized control study was conducted after receiving Ethical permission from the Ethical committee of Superior University, Lahore. The data was collected from the Teaching Hospital affiliated with the University of Lahore. The sample size of sixty-two patients was calculated by using G-power version 3.1.9.4 [mean I= 12.88, mean II= 20.25*, d= 0.85, t= 1.67,* α prob = 0.05, Power = 0.95]. The patients were included in the study according to the defined inclusion and exclusion criteria through a purposive sampling technique. The inclusion criteria of the study were male and female of 45-65 years age (24) who were diagnosed with iliotibial band tightness (ITBT) based on clinical examination and positive Noble compression test with severe lateral knee pain aggravated while performing any physical activity (1). Patients having a history of knee surgery or other knee injuries, other musculoskeletal conditions affecting the knee, Inflammatory conditions such as rheumatoid arthritis or gout, Neurological conditions affecting leg function (32), and Pregnant patients(24) were excluded from the study.
Patients after selection, were randomly divided into two groups through the lottery method. Group A (n= 31), the experimental group, was managed by using Clamshell Techniques with Electrical Muscle Stimulation. On the other hand, Group B (n=31) the Control group was treated through Conservative treatment. In group A; the patient was positioned on the side lying and advised to perform the active clamshell exercise as hip abduction with and without a Thera band and moved in a supine lying position to perform bridging accompanied by Hip abduction with and without Thera band. These exercises would performed in 3 sets of 10 repetitions per leg, 3 times per week (33). After exercises, the EMS was applied to the gluteus medius and minimus muscles for 20 minutes per session having adjusted frequency and intensity according to patient's tolerance. Similarly, EMS was applied 3 times per week (33).
On the Contrary, Group B, the Control Group, managed Conservative treatment as Stretching of lower limb muscles including stretching of the Iliotibial band, Quadriceps, and Hamstring muscles. Each stretch was held for 30 seconds having a 30-second hold, 3 repetitions per leg, 2 times per day (35). The whole sessions of both groups were continued for six weeks. During these sessions, the patient was assessed during the 1st day of sessions a baseline treatment followed by at the end of the fourth week and sixth week. Pain, Flexibility of ITB, Range of motion, and functional status of patients were assessed through a numeric pain rating scale (NPRS), Goniometer, and Lower Extremity Functional Scale (LEFS).
NPRS an 11-point scale, with 0 "no pain" to 10 "worst pain imaginable" is a valid and reliable tool with an ICC value of 0.70 to 0.85 used for measuring pain intensity and severity of pain(30). Additionally, the Goniometer having an aICC of 0.98, is an effective tool used to measure the angle of a joint, and the range of motion of a joint improved through muscular flexibility and capsular laxity (31). The functional status assessed by a patient-rated outcome measure termed LEFS a 20item scale provides in-depth knowledge of patients' initial function, ongoing progress, and outcome for a wide range of lower-extremity conditions(28). With an ICC of 0.98 and Cronbach's alpha of 0.96 LEFS is the most reliable and valid assessment tool for functional measurement (29).
The statistical analysis was performed by SPSS version 24 in which continuous data presented in mean ± SD and frequency (%) used for categorical data. Having a non-significant distribution of data,

non-parametric tests Kruskal Wallis test, and the Friedman test were used for between-group and within-group along with repeated value comparisons; p-value < 0.05 was considered significant.

Result:

The results of the analysis were described in tabulated form in Mean± S.D, frequency (%), and rank with p-values. Table 1 provides statistical analysis of demographic variables including age and gender. Out of 31 participants in group A the mean age was 54.77±5.97 while out of 31 participants in group B the mean age was 55.38 ± 6.54. Additionally, the gender distribution of both groups was further described in Table 1. According to analysis, in group A 16(51.6%) were females and 15(48.4%) were males while out of 31 participants in group B 15(48.4%) were females and 16(51.6%) were males.

Additionally, the within-group analysis determined through the Friedman test is shown in Table 2. According to the table, the value of NPRS, LEFS and ITB length were significantly improved for baseline measurement till the 6th week having P-value <0.05. The analysis confirmed Clamshell exercises and Conservative exercises both were effective in producing noticeable changes in the symptoms of patients. On the contrary, the Knee ranges showed quite varied behavior. Clamshell exercise in combination with EMS produced a significant improvement in knee flexion however, knee extension did not improve from baseline to 6th week, p-value=0.090. Similarly, in the Control group knee ranges, flexions, and extension, were not improved having a p-value of 0.983 and 0.892 respectively. The analysis between different repeated measurements of values mentioned in Table 3 showed significant improvement was only observed in LEFS scoring

However, the comparative analysis was determined through Kruskal Will tests showed nonsignificant, p-value >0.05, results in Table 4, as within both groups confirmed both Clamshell exercises with EMS and Conservative exercises produce equal outcomes in managing IT band tightness.

Table 1: Demographic Variables of Groups:

Variable		Clamshell Group (n=31)	Conservative Group (n=31)
Age		54.77±5.97	55.38 ± 6.54
Gender	**Male**	15(48.4%)	16(51.6%)
	Female	16(51.6%)	15(48.4%)

Table 2: Friedman test- Within Groups Analysis:

Variable		Clamshell Group (n=31)		Conservative Group (n=31)	
		Mean Rank	**Chi-Square**	**Mean Rank**	**Chi-Square**
NPRS	Baseline	3.18	31	3.56	31
	1st week	2.55	20.950	2.71	54.929
	3rd week	2.56	3	2.50	3
	6th week	1.71	.000	1.23	.000
LEFS	Baseline	1.56	31	1.45	31
	1st week	2.23	34.202	2.37	44.990
	3rd week	2.87	3	2.58	3
	6th week	3.34	.000	3.60	.000
ITB length	Baseline	2.47	31	2.32	31
	1st week	3.08	12.000	3.06	10.149

	3rd week	2.50	3	2.55	3
	6th week	1.95	.007	2.06	.017
Knee Flexion ROM	Baseline	1.73	31	2.42	31
	1st week	3.02	32.149	2.53	.167
	3rd week	2.02	3	2.53	3
	6th week	3.24	.000	2.52	.983
Knee Extension ROM	Baseline	2.50	31	2.58	31
	1st week	2.73	6.485	2.60	.618
	3rd week	2.73	3	2.42	3
	6th week	2.05	.090	2.40	.892

Table 3: Pairwise comparison- Within Groups Analysis

Variables			**Clamshell Group (n=31)**			**Conservative Group (n=31)**		
			Mean difference	**Std. Error**	**p**	**Mean difference**	**Std. Error**	**p**
		2	-2.903*	.580	.000	-3.194*	.408	.000
		3	-5.323	2.579	.287	-4.226	3.315	1.000
LEFS	1	4	-10.000*	2.224	.001	-12.548*	2.398	.000
		2	-.097	3.239	1.000	-2.226	3.058	1.000
		3	1.387	3.041	1.000	-.484	2.849	1.000
ITB Length	1	4	2.677	2.852	1.000	.871	2.698	1.000
		2	-4.000	.000	.	-1.355	2.380	1.000
		3	-.839	2.507	1.000	-1.387	2.154	1.000
Knee Flexion ROM	1	4	-4.935	3.012	.671	-1.419	2.071	1.000
		2	-.548	.845	1.000	.968	.774	1.000
		3	-.548	.845	1.000	1.097	.603	.475
Knee Extension ROM	1	4	-.032	.818	1.000	1.097	.547	.325

Table 4: Kruskal-Wallis Test – Between Group analysis of 3 weeks assessment:

Variable		**Mean Rank**		**Kruskal-Wallis H**	**p-value**
		Clamshell Group (n=31)	**Conservative Group (n=31)**		
NPRS	Baseline	33.77	29.23	0.995	0.319
	1st week	32.92	30.08	0.389	0.533
	3rd week	34.44	28.56	1.663	0.197
	6th week	34.68	28.32	1.964	0.161
LEFS	Baseline	32.65	30.35	0.250	0.617
	1st week	32.45	30.55	0.173	0.678
	3rd week	33.06	29.94	0.467	0.494

	6th week	31.56	31.44	0.001	0.978
ITB length	Baseline	32.76	30.24	0.302	0.583
	1st week	31.45	31.55	0.000	0.983
	3rd week	31.58	31.42	0.001	0.972
	6th week	31.66	31.34	0.005	0.944
Knee Flexion ROM	Baseline	30.82	32.18	0.088	0.767
	1st week	32.65	30.35	0.250	0.617
	3rd week	30.32	32.68	0.265	0.607
	6th week	32.97	30.03	0.412	0.521
Knee Extension ROM	Baseline	29.87	33.13	0.510	0.475
	1st week	33.63	29.37	0.874	0.350
	3rd week	34.32	28.68	1.548	0.213
	6th week	32.92	30.08	0.398	0.528

Discussion

The objective of this study was the effects of the Clamshell technique with electrical muscle stimulation versus Conservative treatment in Iliotibial band tightness for pain and function. The analysis confirmed IT band flexibility, knee range of motion, and functional status showed through The Clamshell exercises with EMS and Conservative treatment with a p-value <0.05. However, on comparison, the non-significant results observed concluded none of the exercises produce significantly better results in managing IT band tightness.

According to the Kruskil Wallis test, NPRS measurements, in the Baseline group, the mean rank for group A was 33.77, and for group B was 29.23. The Kruskal-Wallis H test showed a p-value of .319. In Week 1, the mean rank for Group A was 32.92, and for Group B was 30.08. The Kruskal-Wallis H test showed a p-value of .533. In Week 3, the mean rank for Group A was 34.44, and for Group B was 28.56. The Kruskal-Wallis H test showed a p-value of .197. According to the Friedman test for LEFS measurements, Group A showed an increase in mean rank from Baseline to Week 6, with significant Chi-Square values at each time point. Group B also displayed an increase in mean rank over time, with significant Chi-Square values at each time point as well. The data suggests improvements in functional ability for both groups over the study period.

Group A pairwise comparisons revealed significant mean differences between certain pairs, with confidence intervals indicating the range of the differences. Group B comparisons also showed significant mean differences at the .05 level, with adjustments made for multiple comparisons. The study's findings highlight the importance of pairwise comparisons in analyzing differences between groups based on the band measure.

Imeri B et al (2020) investigated the effect of a special strengthening exercise program for abductor's muscles according to NSCA protocol, on pain reduction and lower extremity function improvement among elite distance runners with ITBS. The subjects in this study were 32 elite distance runners who were randomly divided into two groups of control and experimental n=16 in each. In contrast with our study, out of 62 participants in total, there were 31 in each group control and experimental. Imeri et al. indicated that the strengthening exercise program on hip abductor muscles caused a significant decrease in pain (P=0.0001) (36). While in our study, we found similar results, Group A showed a decrease in mean rank from 3.18 at baseline to 1.71 at week 6, with significant Chi-Square values at each time point. Group B also exhibited a decline in mean rank from 3.56 at baseline to 1.23 at week

6, with significant Chi-Square values throughout the study period. The data suggests a notable improvement in pain ratings for both groups over the weeks.

Jeong et al. (2019) compared the effects of three different clamshell exercises (CLAM) on the hip flexors and knee extensors. GMED and the QL muscle activities did not differ significantly between the standard CLAM and the modified CLAM with the 2 different foot positions (F= 4.74, P=. 02; F= 4.57, P=. 02, respectively). AHF activity was significantly different in the two different foot positions when compared to the standard CLAM (F= 11.17, P=. 00) (37). However, there was no significant difference between the anterior hip flexor activities for the two different foot positions (P=. 09). In comparison with our study, we found opposite results, Group A showed slight variations in knee extension ROM° over the weeks, while Group B had more consistent values. The Chi-Square values indicate the significance of the differences observed in knee extension ROM° between the groups.

The findings of our study are consistent with previous research on the management of iliotibial band tightness and associated symptoms. A study by (38) found that a combination of stretching and strengthening exercises was effective in improving the range of motion and reducing pain in individuals with iliotibial band syndrome. Additionally, a review by (34) highlighted the potential benefits of electrical muscle stimulation in the treatment of various musculoskeletal conditions, including iliotibial band tightness.

A recent study by Friede et al.(2020) used the same technique to test the hypothesis that, as compared to healthy controls, the ITB stiffness would be greater in runners with ITBS (18). Against expectations, no significant differences in ITB stiffness were found. Moreover, TFL stiffness was significantly lower in ITBS patients. While the reasons for the decreased muscle stiffness are unclear, it may be speculated that in ITBS patients the neural drive to the TFL would be involuntarily reduced in an attempt to lower its resting tone and, thus, the compression of tissues beneath the ITB.

Having its advantages, the current study had some limitations that needed to be managed in future studies. Primarily, the duration of the follow-up in the study was limited, potentially not capturing the long-term effects of the intervention. So it is recommended to conduct longitudinal studies with extended follow-up periods to assess the long-term effects of interventions such as the clamshell technique with electrical muscle stimulation compared to conservative treatments. Furthermore, Variability in the treatment protocols used for the clamshell technique, electrical muscle stimulation, and conservative treatments across studies can make it challenging to directly compare the interventions. Standardization of protocols is crucial for accurate comparisons. Therefore, it is necessary to standardize the intervention protocol through treatment approach. Lastly, the limited generalizability of the findings to a broader population with iliotibial band tightness makes it necessary to include a diverse population of different ages, genders, activity levels, and underlying conditions in future research studies to improve the generalizability of findings and for better understanding of researchers and physiotherapist that how these interventions may impact a broader range of individuals with iliotibial band tightness

Conclusion:

The comparative effects of the clamshell technique with electrical muscle stimulation versus conservative treatment in iliotibial band tightness for pain and function are crucial to understanding. While the clamshell technique and electrical muscle stimulation have shown promising results in reducing pain and improving function, conservative treatments such as stretching and strengthening exercises are also effective.

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