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Effectiveness of Corrective Exercise Program and Kinesio Taping in Management of Patellofemoral Pain Syndrome

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Patellofemoral pain syndrome (PFPS) is a common musculoskeletal condition, particularly among young adults. PFPS usually presents with anterior knee pain, weakness of gluteal muscles and impaired motor control during activities of daily living. A corrective exercise program (CEP) consisting of neuromuscular training and hip muscle strengthening in conjunction with Kinesio taping is an effective management strategy. Thirty patients with PFPS participated in this study design. Two groups were formed, one of which (n=15) received CEP and Kinesio Taping. The other group (n=15) received only Kinesio Taping. The outcome was measured using a Patient Specific Functional Scale and a Visual Analogue Scale. After a four-week program that included three sessions per week of CEP, it was observed that CEP combined with Kinesio Taping produced a more substantial and positive result than the other group. CEP in conjunction with Kinesio Taping was found to be an effective management strategy in PFPS. CEP with Kinesio Taping resulted in significant pain reduction and improvement in activities of daily living in young adult population with PFPS.

Keywords: PFPS; Kinesio Taping; Corrective Exercise Program (CEP)

I. INTRODUCTION

Patellofemoral Pain Syndrome (PFPS) is one of the most common conditions encountered in the clinical setting. It is estimated that about 7% to 40% of adolescents and active adults face this problem (Lowry *et al.,* 2008). PFPS is a condition presented as anterior knee pain or pain behind the patella (retro patellar pain). It is noted that women have a higher incidence of PFPS than men (Lankhorst *et al.,* 2012). The reason for women being affected more is because the Q-angle in women is higher than in men. There are various reasons for this condition like abnormal lower limb biomechanics, soft tissue tightness, muscle weakness and overexercising (Fredericson & Yoon, 2006). Also, evidence suggests that malalignment of the patella, or altered patellar tracking, maybe a predisposing factor for patellofemoral pain, chondromalacia, and articular cartilage degeneration (Chang *et al.,* 2015). PFPS is commonly experienced during running, squatting, stair climbing, prolonged sitting, and kneeling (Logan *et al.,* 2017). Evidence suggests that the insufficiency of the musculature surrounding the knee joint may reduce the function of the patella at the knee joint (Montalvo *et al.,* 2014). An ultrasonography study on 61 volunteers found that the patellar and quadriceps tendon thickness were remarkably higher in the volunteers with PFPS, than the normal subjects (Kizilkaya & Ecesoy, 2019). Physical therapy interventions for PFPS often are intended to alleviate pain by correcting or improving proper patellar tracking within the patellofemoral groove. Conservative management includes patellar taping; stretching of the lower extremity muscles, including the quadriceps, hamstrings, gastrocnemius, anterior tibialis, iliotibial band, and gluteal muscles; stretching of tight structures such as the lateral retinaculum; strengthening of the VMO; activity modification; biofeedback; neuromuscular electric

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stimulation; ultrasound; thermotherapy; bracing; and foot orthotics (Lankhorst *et. al.,* 2012; Banerjee *et al.,* 2016).

The mechanical correction technique as in Kinesio taping should be thought of as positional in nature and not as an attempt to keep the tissue or joint in a fixed position. This technique uses the properties of the Kinesio Tape, through the application of moderate to severe tension, to provide a stimulus perceived by the mechanoreceptors. The degree of stimulation is determined by the combination of appropriate tension and inward pressure that provides stimulus to deeper tissue. The practitioner will need to adjust the application technique to the needs of the patient and also can either use the stimulus effect of the elastic qualities of the tape to create a corrective reaction or position the tissue without movement (Mostamand *et al.,* 2021).

Though regular treatment options like stretching of lower extremity muscles and application of ice is found to be beneficial for reducing the symptoms and swelling of PFPS, Kinesio taping is found beneficial for the subjects with PFPS (Wei *et al.,* 2020). In recent times, along with Taping, several strengthening exercises and stretching programs were also prescribed to patients with different syndromes to get a better output (Gohil *et al.,* 2021). However, there are no studies available to our knowledge on the effectiveness of Kinesio Taping with a Corrective Exercise Program (CEP) in patients with PFPS. Therefore, there is a need to know the comparative effectiveness of the taping methods on pain and functional activities in patients with PFPS with a corrective exercise program. Hence the present study is proposed to study the comparative effectiveness of Kinesio Taping over CEP in the treatment of patients with PFPS on pain levels using Patient Specific Functional Scale (PSFS) and Visual Analogue Scale (VAS) as an outcome measure tools.

II. MATERIALS AND METHOD

After obtaining the ethical committee approval, data collection was done at Saveetha Medical Hospital, Saveetha Institute of Medical And Technical Sciences (SIMATS), Chennai, India. A sampling method of non-probability, convenience sampling was followed. Patients who were clinically diagnosed with PFPS by the Physician with the age group between 18 to 40 years of both the male and female gender were selected for this study. Subjects with a ligament injury, infection, and recent fracture in the knee were excluded from this study. After considering the inclusion and exclusion criteria, 30 subjects were selected for this experimental study. After obtaining the consent, baseline assessments like age, sex, date of diagnosis, pain severity, and past history were noted for all the subjects. 15 subjects were taken into Group A and the other 15 into Group B. Before applying Kinesio Taping, all the subjects of Group A and B were assessed using PSFS and VAS, and the data feedback provided by the subjects were recorded. PSFS measures the functional ability of a subject while performing a particular task. Whilst, VAS measures the intensity of pain perceived by the subjects while performing a particular task or PSFS.

After measuring the PSFS and VAS, passive lower limb stretches for the muscles like quadriceps, hamstrings, iliotibial band, gastrocnemius was provided to all the subjects of Group A. Followed by stretches, Kinesio Taping was done. Two 'Y 'cut Kinesio strips were taken. The first strip was applied on the superior part of the patella to tip the inferior pole out of the fat pad. The next tape starts at the tibial tuberosity and goes out wide to the medial knee joint. The soft tissue is lifted towards the patella. The final tape starts at the tibial tuberosity goes wide to the lateral joint line. The application of Kinesio Taping is shown in Figure 1.

A CEP consisting of strengthening exercises for hip (abductors and external rotators), knee (extensors), and Neuromuscular exercises were taught to the subjects. The following exercises were included for the first 3 weeks - side lying hip abduction, knee extension, squats, lateral band walking, forward lunges and eccentric adduction of hip. The load during training session was standardised using a medium level resistance loop band. One leg balance with knee flexion and one leg squats were prescribed at the 4th week of the study design, along with the previous set of exercises. All CEP sessions were performed for 15 to 20 minutes for 3 days per week.

CEP and Kinesio Taping were administered to Group A for 3 sessions a week, for 4 weeks. Whereas, Group B received only Kinesio Taping. After completing 4 weeks of treatment, all the subjects of Group A and B were again assessed using PSFS and VAS. Both the PSFS and VAS were measured in terms of scores provided by the subjects.

Figure 1. Kinesio Taping for PFPS

III. RESULT AND DISCUSSION

This study was conducted on 30 subjects. While the mean age of Group A and B were 30 and 28 years, respectively. There were 6 males and 9 females in both the groups, thereby concluding that there was homogeneity between both the groups. The data obtained from PSFS and VAS were analysed using Paired *t*-test with a 95% level of significance and *p*-value of 0.05. The inferential statistics showed that the mean and standard deviation of Group A pre-test VAS was 7.33 ± 0.72 cm, while for Group B it was 7.20 ±0.77 cm. After the application of CEP and Kinesio Taping, the mean and standard deviation of Group A post-test VAS was 1.87 ±0.83 cm. Whereas for Group B, it was 3.07 ±1.10 cm. The degrees of freedom were 14, with the *t*-value of 23.127 for Group A and 11.374 for Group B. From the student's t distribution table, the critical value for 14 degrees of freedom was found to be 2.1448, which is very smaller than both the t-values 23.127 and 11.374. The 95% confidence interval did not cross '0'. Both the upper and lower values for both the groups were on positive and on the same side. The p-value for both Group A and Group B was 0.000, which is lesser than 0.05. Therefore, this study concludes that there is a significant difference between pre and post-test. The application of CEP and Kinesio Taping do show a significant improvement in the subjects 'pain reduction. This may be due to the off-loading effect produced by the tape on the patella when it is medially glided, and the contact between the patella and the femur is reduced, and thus reduction of pain. Also, the mechanoreceptor stimulation effect caused by the tape and tension in the band moderated to the severe cause of mechanical correction effect. The results of this analysis are provided in Table 1.

All exercises prescribed in the CEP for Group A were evidence based and scientifically proven list of exercises (dos Anjos Rabelo *et al.*, 2014). We also examined the day to day activities commonly affected in PFPS, that included activities like standing upright, toileting, forward bending, sitting, walking on a flat surface, ascending, and descending stairs. On evaluating the mean PFPS scores of various activities between pre-test and post-test of Group A, it was clear that the post-test scores were significantly different from the pre-test scores. The application of Kinesio Taping and CEP to patients suffering from PFPS do provide better results. The results of this analysis are provided in Table 2. On evaluating the mean PSFS scores of various activities between pre-test and post-test of Group B, it was clear that the post-test scores were significantly different from the pre-test scores. Similarly, application of Kinesio Taping alone without any corrective exercises too produce a significant difference. The results of this analysis are provided in Table 3.

As this study mainly focuses on the implementation of a Corrective Exercise Program along with Kinesio Taping, another analysis was done on the post-test results of PSFS between Group A and Group B. The post-test mean scores of various activities were compared between Group A and Group B. Interestingly, among the seven activities, five activities showed a significant difference. Only two activities namely standing upright and sitting showed no significant difference. The results of this analysis are provided in Table 4.

From Table 4 it can be inferred that activities involving multiple knee joint function like walking, stair climbing, and descending showed a significant difference between the two groups. Whereas, activities involving less of knee joint function and more of other joints like standing and sitting showed no significant difference. PFPS is often associated with obesity. According to recent research (Park *et al.,* 2019), those with a BMI of more than 30 kg/m^2 are 6.8 times more likely to suffer from PFPS. This suggests that maintaining proper fitness and reducing obesity can also prevent occurring of PFPS. From the literature review (Espi Lopez *et*.

al., 2017; Motealleh *et al.,* 2019), it was evident that a combined therapy or a combined treatment plays a major role in treating PFPS. Likewise, the results of a study conducted by Gohil *et al.* (2021) on the combined effect of Kinesio taping and exercises on pain and function in individuals having patellofemoral pain syndrome with different grades of obesity, support the findings of this study (Gohil *et al.,* 2021). They conducted their study with thirty-six participants who received both the taping and exercises for four weeks, found that the pre test and post test results had a significant improvement. However, the implication of obesity and its grades did not affect the outcome of their study. A pilot study conducted by Arrebola *et al.* (2020) on forty-three women suffering from PFPS found that the application technique of Kinesio taping is more important than the exercise (Arrebola *et al.,* 2020). The forty-three subjects were divided in three groups. One group received Kinesio taping for patellar medialisation, another with lateral rotation of the femur and tibia, and other as a control group. They received treatment for 12 weeks and used numerical pain rating scale, anterior knee pain scale, and single jump hop test as their outcome measures. Apart from these studies, few other studies also recommend the importance of stretching as a treatment in PFPS. A study conducted by Kalai *et al.* (2018) in 2018 concluded that strengthening of hip external rotators and abductors along with a hip internal rotator stretch provide a better outcome in regards to pain reduction and improved functional ability in patients suffering from PFPS (Kalai *et al.,* 2018).

Apart from the combined therapy, while treating PFPS, proper attention must be given to the hip and ankle joint as well. A systematic review conducted by Gilson *et al.* (2020) on the effectiveness of hip strengthening exercises in managing PFPS concluded that a combined hip and knee treatment approach was more effective in pain reduction rather than administering knee exercises alone (Gilson *et al.,* 2020). Our study included several strengthening exercises, stretches which targets multiple joints and muscles in treating PFPS. Apart from the general basic isometric, isotonic, and isokinetic exercises, the CEP containing exercises like quadriceps setting, seated knee extension, SLR, lateral SLR, pelvic bridging, curl up with a pillow between the flexed knee, lateral curl up, lunges, 30° knee squatting, and posture control exercises. This apart, we pragmatically included postural control exercises in our CEP. A recent research conducted by Motealleh *et al.* (2019) found that the anterior posterior center of pressure, lateral displacement of center of pressure, and mean center of pressure velocity were significantly high in the subjects with PFPS than the healthy normal subjects (Motealleh *et al.,* 2019). They concluded that, offering postural control exercises along with conventional physical therapy management in patients with PFPS may have beneficial effects. Therefore, the CEP followed in this study covering multiple joints and muscles alongside the Kinesio Taping proved to be more effective than the general muscle stretches and Kinesio Taping, which can be inferred from the results mentioned above.

There were two limitations in this study. First, using a small sample size. Only 30 subjects participated in this study. Large sample size could have provided more validation to the results found. Second, this study did not make any follow up. This study got completed at the end of the fourth week. However, a long term follow-up along with the subject BMI and using a large sample size is advisable. Adding to that, upcoming studies shall find the pathomechanics and altered biomechanics of PFPS using a least data available, like X-rays (Palaniswamy *et al.,* 2018), or compare different types of Taping on the knee with different glides and varying the direction of pull (Arrebola *et al.,* 2020).

Table 1. Analysis of Pre-test and Post-test VAS scores in Group A and Group B

	Pre-test (Mean ± SD)	**Post-test (Mean ± SD)**	**Df**	***t*-value**	**95% Confidence Interval of the Difference**		***p*-value**
					Lower	**Upper**	
Group A	7.33 ± 0.72	1.87 ± 0.83	14	23.127	4.960	5.974	0.000
Group B	7.20 ± 0.77	3.07 ± 1.10	14	11.374	3.425	4.913	0.000

Table 2. Analysis of PSFS in Group A between Pre-test and Post-test

	Pre-test (Mean ± SD)	Post-test (Mean ± SD)	*t*-value	95% Confidence Interval of the Difference		*p*-value
				Lower	Upper	
Standing upright	7.40 ± 1.29	2.13 ± 1.06	10.115	4.150	6.383	0.000
Toileting	4.20 ± 1.47	2.47 ± 1.24	3.452	0.657	2.810	0.04
Bending	6.80 ± 1.47	1.67 ± 0.61	13.642	4.326	5.940	0.000
Sitting	6.73 ± 1.33	2.20 ± 0.86	10.169	3.577	5.489	0.000
Walking on flat surface	5.73 ±1.28	1.87 ± 0.74	11.502	3.146	4.588	0.000
Ascending stairs	7.13 ± 1.06	2.07 ± 0.88	14.704	4.328	5.806	0.000
Descending stairs	6.53 ± 0.83	1.93 ± 0.79	18.076	4.054	5.146	0.000

Table 3. Analysis of PSFS in Group B between Pre-test and Post-test

	Pre-test (Mean ± SD)	Post-test (Mean ± SD)	*t*-value	95% Confidence Interval of the Difference		*p*-value
				Lower	Upper	
Standing upright	7.40 ± 1.29	3.07 ± 1.43	9.127	3.315	5.352	0.000
Toileting	4.20 ± 1.47	3.53 ± 1.06	2.092	0.017	1.350	0.05
Bending	6.80 ± 1.47	3.33 ± 1.54	7.970	2.534	4.400	0.000
Sitting	7.07 ± 0.88	2.93 ± 1.16	10.633	3.300	4.967	0.000
Walking on flat surface	5.73 ± 1.28	3.53 ± 0.91	4.896	1.236	3.164	0.000
Ascending stairs	7.13 ± 1.06	3.07 ± 1.10	10.956	3.271	4.863	0.000
Descending stairs	6.53 ± 0.83	3.13 ± 1.06	9.379	2.622	4.178	0.000

Table 4. Analysis of Post-test PSFS between Group A and B

	Group A (Mean ± SD)	Group B (Mean ± SD)	*t*-value	95% Confidence Interval of the Difference		*p*-value
				Lower	Upper	
Standing upright	2.13 ± 1.06	3.07 ± 1.43	- 2.024	- 1.878	0.011	0.053
Toileting	2.47 ± 1.24	3.53 ± 1.06	- 2.525	- 1.932	- 0.201	0.018
Bending	1.67 ± 0.61	3.33 ± 1.54	- 3.884	- 2.546	- 0.788	0.001
Sitting	2.20 ± 0.86	2.93 ± 1.16	- 1.962	- 1.499	0.032	0.060
Walking on flat surface	1.87 ± 0.74	3.53 ± 0.91	- 5.474	- 2.290	- 1.043	0.000
Ascending stairs	2.07 ± 0.88	3.07 ± 1.10	- 2.745	- 1.746	- 0.254	0.010
Descending stairs	1.93 ± 0.79	3.13 ± 1.06	- 3.501	- 1.902	- 0.498	0.002

IV. CONCLUSION

Based on the analysis, the present study concludes that CEP in conjunction with Kinesio Taping is more effective than Kinesio Taping alone in improving the pain levels and functional activities in patients with PFPS. Significant pain reduction and improvement in ADL was found when CEP was given along with Kinesio Taping in young adult population.

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