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Original Article

Effects of Trigger Point Dry Needling in Patients with Patellofemoral Pain Syndrome; A Randomized Controlled Trial

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ABSTRACT

Background: Patellofemoral pain syndrome is recognized as a complex and widespread disorder of the knee that commonly affects women. Dry needling is an effective approach used for the rehabilitation of a large number of musculoskeletal dysfunctions. **Objective:** To find out the effects of trigger point dry needling on the quadriceps femoris muscle considering pain and functionality in patients suffering from patellofemoral pain syndrome. **Methods:** In this randomized controlled trial, 92 patients were recruited who were clinically diagnosed with the patellofemoral syndrome, aged between 20 to 30 years. Non-probability sampling technique was used to select participants in this study. After preliminary screening, the participants were randomly allocated to the control and experimental group by using the sealed envelope method. The control group was treated with conventional therapy only while the experimental group was treated with trigger point dry needling in the quadriceps femoris muscle along with conventional therapy also. The tools which were employed to measure the intensity of pain were Kujala anterior knee pain scale and numeric pain rating scale at rest, stair climbing and squatting positions before and after the 3rd session of the treatment plan. The data were analyzed using a statistical package for social sciences version 23. Mann Whitney U-test was employed for analyzing the difference between the groups. Wilcoxon signed-rank test was used for analyzing the difference between the follow-ups. **Results:** The mean age and standard deviation for the experimental group was 26.86±3.44 while the mean and standard deviation for the control group was 26.89±4.14 years. All the tools employed and variables of this study showed statistically significant improvement in the experimental group, that is Kujala anterior knee pain scale score ($p<0.001$), numeric pain rating scale score at rest ($p<0.001$), at stairs ($p<0.001$) and at squatting ($p<0.001$). **Conclusion:** The results of current randomized trial concluded that the trigger point dry needling is an effective treatment approach in reducing pain and improving functioning in patients with patellofemoral pain syndrome when compared with conventional therapy.

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INTRODUCTION

Patellofemoral pain syndrome (PPS) is recognized as the most common cause of knee pain in female athletes which occurs as a result of imbalances in the forces which control the tracking of the patella during knee flexion and knee extension, caused pain in the anterior aspect of the knee.[1] The symptoms of PPS include pain around or behind the patella that aggravates while running or any other activities which involve knee flexion such as climbing stairs, coming down from stairs and squatting, affecting females as compared to males.[2]

There is a difficulty in defining PPS because the sufferers experience a wide range of symptoms and intensity of physical impairments and pain.[3-7] Furthermore the most recent literature has been focused on studies that were performed with male participants, which limits the knowledge and literature of treatment approaches for females suffering from PPS.[8] This is the most widespread orthopedic condition observed in sports medicine and the most commonly observed preset complaint in young adults and adolescents.[9,10] It is also recognized as the primary diagnosis in almost 25 percent of all injuries which involve running.[11,12]

The treatment approaches for PPS are promising only for the short term, but considering the long-term results from the results are less efficacious.[13] The occurrence of PPS varies from 8.75 to 17%, nevertheless its occurrence among females is much higher when compared to males.[14] Those young females who participate regularly in jumping activities and running might be principally at risk.[2] A study performed on 40 women suffering from PPS showed that the pain was highly associated with increased activity. Apart from malalignment, chronic overuse and overloading of the patellofemoral joint might also be the causes of patellofemoral pain.[15] A study conducted by Boling and co-workers found that women are 2.23 times more probable to develop PPS when compared with men.[16] In addition to this, Boling and his co-workers found out that the prevalence of PPS had no significant difference between genders when they were admitted to the United States Naval Academy. Their results of some other studies suggested that women are more affected than men by a rigorous increase in the level of physical activities, which in turn eventually leads to a greater rate of incidence of PPS.[16,17]

There are multifactorial causes of PPS in females and they also include injuries of the extensor apparatus, insertional tendonitis, chondral and osteochondral damage and patellar instability.[18] The most common treatment approaches used for PPS are conservative while the surgical interventions are much less common. A very extensive range of treatment plans are used for PPS but some substantial components include increasing flexibility, strength, endurance, proprioception, function training and then gradual progression.

The best course of treatment is a multimodal non-operative therapy along with using NSAIDs for a short period, directed tape medially and complex exercise programs including exercises for the lower extremity, core, hip and trunk muscles.[3] With the improvement and development of the therapeutic field, dry needling has gained the attention of clinicians and researchers because of evidence supporting its effectiveness. Describing dry needling functionally involves inserting small filament needles into the trigger points to reduce pain, and tenderness and improve the functionality of the muscles.[19] This current randomized controlled

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trial will also add more to the evidence supporting the effects of dry needling for reducing symptoms of patellofemoral pain syndrome. Most of the researchers stated that trigger points are bands that are palpable and tenderness of muscle and soft tissues which causes pain and muscle weakness. A large number of studies have shown that patients suffering from PPS complain about weakness in the muscles and have restricted movement of the quadriceps muscle. There is the presence of trigger points in three out of four quadriceps muscles and it can create pre-patellar pain in the anterior aspect of the knee which is a common indication of PPS.[20]

Very few researchers have worked on investigating the effects of dry needling for managing the symptoms of PPS, but it is concluded that dry needling is an effective approach for the rehabilitation of a large number of musculoskeletal dysfunctions.[21] That is why this current study has been conducted to fill this gap. Despite the high prevalence rate of PPS, only a limited number of studies have been conducted to find out the effects of dry needling on the management of PPS. A large number of earlier studies investigated the effects of dry needling in managing pain in the lower back, and neck and rehabilitation of shoulder functioning.[22]

Moreover, one of the main drawbacks of the studies conducted earlier on dry needling management of PPS was that those studies had demonstrated only a single session which was not enough to augment the long-term effects and it had also developed a huge gap in exploring the effectiveness of dry needling for the functional disorders of the lower extremity.[22] While considering the field of scientific research, it is extremely substantial for the researcher to implement the best possible treatment approach that can aid in investigating the causal effects and how it responds to the proposed research objectives. Researchers also state that various methodologies have been introduced in the field of scientific research. Although, every methodology has its drawback and uniqueness. Consequently, envisaging the scope of the research and then choosing the most appropriate treatment approach is extensively substantial for the researcher. This current trial would add significant, authentic and reliable information to the literature considering the most appropriate treatment approach for treating PPS or at least the most suitable treatment approach to reduce the symptoms associated with PPS.

METHODS

Ethical approval was gained before the conduction of the trial from the research and ethics committee of Riphah International University, Islamabad Campus. The sample size was calculated to be 92, which was calculated using open-epi tool. The following formula was used to calculate the sample size:

$$n=\frac{2\hat{A}\sigma^2(z_{1-\alpha/2}+z_{1-\beta})^2}{(\mu_1-\mu_2)^2}$$

Non-probability sampling technique was employed for the sampling procedure. Before allocating the participants into two groups, the sealed envelope method was used. Before starting the treatment procedure and the interventional measurements, the baseline scores were taken to make sure that there was no difference between the participants in both groups. This research was conducted in the physiotherapy department of Railway General hospital and THQ hospital Taunsa Sharif, Pakistan. Participants with ages ranging between 20 to 30 years[24] who were clinically diagnosed with PPS,[25] participants who had the presence of active trigger points in their quadriceps femoris muscle and who had scores greater than three on numeric pain rating scales were recruited in this study.

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The trigger points in the quadriceps femoris muscle were assessed by applying pressure manually and in the case of jump sign, the exact location of the trigger point was recognized. Patients with knee osteoarthritis, meniscal tear, patellar tendinopathy, ligamentous injuries were excluded from this study. Patient who had any pathology involving peripheral nerve involvement and lumbosacral nerve root were also excluded from this study. Before starting the treatment procedure, all the participants were given an entire detail of the purpose of this study and the treatment procedure.

Informed written consent forms in Urdu and English were signed by each participant before the assessment and the treatment procedure. The participants were also informed that these treatment procedures would not have any effect on them and in the case of any ambiguous information or harmful effects, the participant has all the rights to quit the treatment process. All the participants were given three treatment sessions. The anterior knee pain rating scale is an originally thirteen-item scale questionnaire that is based on the Modified Larson scale.

But due to its employees on a larger scale, this questionnaire was altered which specifically included questions that can help the researcher in documenting the responses to six activities that are, walking, running, jumping, squatting, sitting and climbing stairs for a prolonged period.[26] The maximum score on this scale is 100, a score closer to 100 represents a good score and suggests that the patient does not need any further treatment. The value of the score closer to 70 represents the moderate score and suggests treatment for the patellofemoral pain and the score which is below 50 represents severe pain.[27] While talking about the reliability and validity of this scale the researchers have concluded that this questionnaire is exceedingly responsive have shown to have a 93% reliability factor.[28] The numeric pain rating scale (NPRS) is considered the most simplest and commonest scale that is employed to measure the severity of pain. This scale comprises of total 10 points, from zero to ten where the score zero represents no pain while the increasing score represents the increasing intensity of pain and consequently, it warrants the requirement of the treatment.[29]

The participants present in both the groups, control and experimental were treated with a conventional physiotherapy regime which included the application of a hot pack for ten minutes before the initiation of the session, stretching of the quadriceps femoris muscle with four repetitions and maximum hold of fifteen seconds per session[13] (Table I). Additionally, the patients in the control group were also treated with the isometric exercise of the quadriceps femoris muscle and three sets of strengthening the vastus medialis oblique with ten repetitions in each session. The experimental group was also treated with the same conventional physical therapy with three sessions of dry needling on alternative days.

While performing it, the location of the trigger point was sterilized using the alcohol cotton swabs and the needle of size 0.25*40 millimeter was inserted on the recognized trigger point. After a period of a few seconds, the needle was manually rotated at the trigger point to resolve the trigger point.[18] After completing the session, the patients were also given instructions to perform some home plan exercises. After gaining the data, it was analyzed using a statistical package for social sciences version 23. Mann Whitney U-test was employed for analyzing the difference between the groups. Wilcoxon signed-rank test was used for analyzing the difference between the follow-ups.

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Figure I CONSORT Diagram

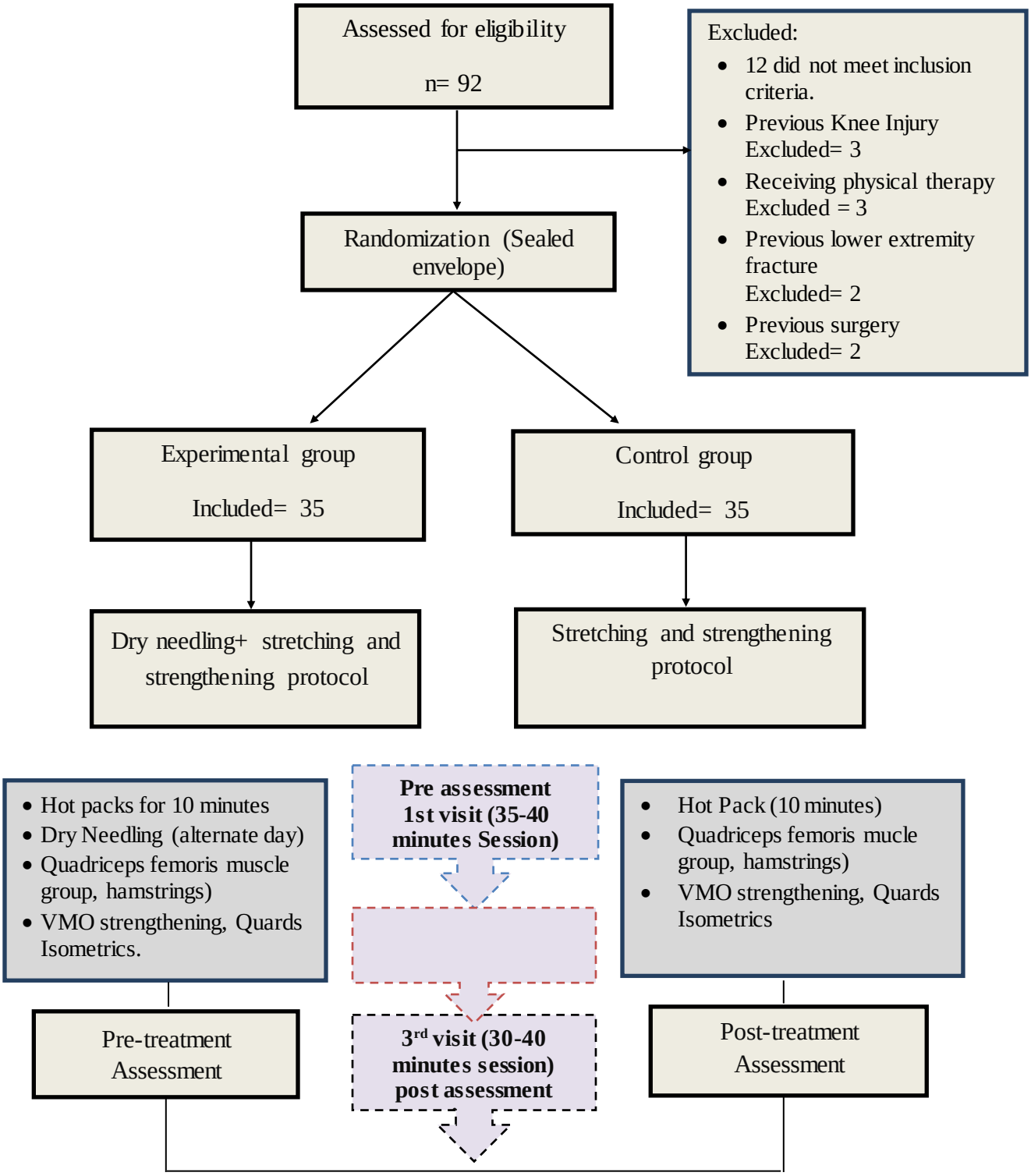

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Table I: Treatment Protocol for Experimental and Control Groups

Groups	Protocol	Intensity
Experimental Group	Hot pack on knee and quadricep femoris muscles before the session for general relaxation[30, 31] Strengthening protocols of quadriceps muscles[32] Three sessions of dry needling[13] Stretching protocol[18]	Hot pack for 10 minutes Stretching of quadriceps femoris muscle with four repetitions and 15-second hold per session[18] Three sets of 10 RM with progressive loading per session[32] Dry needling of quadriceps femoris muscle on alternate day[13]
Control Group	Hot pack on knee and quadriceps femoris muscle before the session for general relaxation[30, 31] Stretching protocol[18] Strengthening protocols of quadriceps muscles[32]	Hot pack for 10 minutes Stretching of quadriceps femoris muscle with four repetitions and 15 seconds hold per session[33] Three sets of 10 RM with progressive loading per session[32]

RESULTS

Considering the objectives of this randomized controlled trial, the data collected by the selected sample size was analyzed using statistical package for social sciences version 23. To investigate the effects of trigger point dry needling on the symptoms of PPS, data was analyzed between the follow-ups and the groups. For experimental and control groups, analysis at pre and post-treatment levels, Wilcoxon sign-rank test was applied. The mean ranks at both levels were the same, but the median (IQ) for an experimental group that was 2(1) was lower than the control group 4(1) in Table III. By employing the Wilcoxon signed-rank test, it was analyzed that the pre and post-mean rank of both the groups were (18), but the median (IQ) for the experimental group was 3(1) which was lower than the control group (5)1. Based on results, it was found that trigger point dry needling has significantly decreased the intensity of pain in the experimental group.

Similarly, the pre and post-data for NPRS-squatting were also analyzed. The pre and post-mean rank was (18) for both the experimental and control groups. Although, the post-median test (IQ) for the experimental group was 3(1) which was significantly lower than the control group 6(1) with a $p<0.001$. Based on the period, a comparison with the group was also analyzed. The Kujala anterior knee pain scale for both the experimental and control group were analyzed (Table III). The pre and post-mean rank for both the experimental and control groups was the same

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Table II: Demographics

Variables		Experimental Group	Control Group
Age (years) Mean ± S.D		26.86 ± 3.44	26.89 ± 4.15
Gender N (%)	Male	13 (37.1%)	19 (54.3%)
	Female	22 (62.9%)	16 (45.7%)

Table III: Between-Group Comparison of Experimental and Control Groups

Variables		Groups	n	Mean Rank	Med (IQ)	p-value
AKPS	Pre-test	Experimental	35	34.31	54 (11)	0.626
		Control	35	36.69	55 (10)	
	Post-test	Experimental	35	43.87	72 (14)	<0.001**
		Control	35	27.13	65 (13)	
NPRS-R	Pre-test	Experimental	35	33.50	8 (1)	0.370
		Control	35	37.50	8 (1)	
	Post-test	Experimental	35	19.13	2 (1)	<0.01***
		Control	35	51.87	4 (1)	
NPRS-St	Pre-test	Experimental	35	38.14	9 (0)	0.235
		Control	35	32.86	8 (1)	
	Post-test	Experimental	35	18.41	3 (1)	<0.01***
		Control	35	52.59	5 (1)	
NPRS-Sq	Pre-test	Experimental	35	35.64	8 (1)	0.948
		Control	35	35.36	9 (1)	
	Post-test	Experimental	35	19.67	3 (1)	<0.01***
		Control	35	51.33	6 (1)	

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Table IV: Within-Group Comparison of Experimental and Control Groups

Variables	Groups	n	Pre-test		Post-test		p-value
			Mean R	Median (IQR)	Mean R	Median (IQR)	
AKPS	Experimental	35	18	54 (11)	18	72 (10)	<0.01***
	Control	35		55 (14)		65 (13)	<0.01***
NPRS-R	Experimental	35	18	8 (1)	18	2 (1)	<0.01***
	Control	35		8 (1)		4 (1)	<0.01***
NPRS-St	Experimental	35	18	9 (1)	18	3 (1)	<0.01***
	Control	35		8 (2)		5 (1)	<0.01***
NPRS-Sq	Experimental	35	18	8 (1)	18	3 (1)	<0.01***
	Control	35		9 (1)		6 (1)	<0.01***

(18), but the median (IQ) for the experimental group was 72(10) which was greater than the control group's 65(130). As the higher score on the Kujala anterior knee pain scale indicated lower pain intensity. In the due course, it was interpreted that dry needling of trigger points significantly reduced the intensity of pain within the experimental group as compared to the control group.

DISCUSSION

The main goal of this current study was to determine the effects of trigger point dry needling for reducing the pain caused in patients with PPS. The 72 hours follow-up showed us that the patients in the experimental group have shown significant improvements based on Kujala anterior knee pain scale and NPRS. While on the other hand, the patients in the control group who underwent manual therapy only has shown only mild reduction in the intensity of pain and their functional activities. Talking about the results of this study, the non-parametric Mann Whitney U-test shows that all the parameters of the Kujala anterior knee pain scale have significantly shown improvement within the experimental group because of trigger point dry needling and therapeutic exercises. The patients in the control group also revealed a reduction in pain. Although, the intensity of pain within the control group was not reduced as much as observed within the experimental group.

To validate the results, the patients were also assessed based on NPRS at two different positions. The patients were observed to show statistically significant improvements in all the 3 positions and the patients in the experimental group reported a 60% reduction in pain and showed improvement in the

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functional activity of their knee joint. To improvise the results of this study, comparisons were carried out on the base of the period between the groups. While collecting data from the patients, patients from both groups revealed improvements in their functional activities and a reduction in pain. Based on the Wilcoxon signed rank test, it was observed that the comparison between periods had almost the same results between the groups. Based on these findings, this research authenticates the fact that trigger point dry needling might significantly contribute towards the rehabilitation of the PPS. This study also suggests that trigger point dry needling might not have shown similar results if the patients were only treated with dry needling alone.

The therapeutic exercises reflect the desired outcomes in the process of rehabilitation in the longer run. Although, with the aid of interventional measures such as dry needling, the entire time duration of the treatment process might be lessened, time-saving and might produce better results. A study conducted by Llamas-Ramos and co-workers showed the effects of dry needling for managing pain in the neck. The results of their study showed improvements in mechanical neck pain spontaneously within one and a half days.

However, the researchers have also stated a limitation of their study that they are not sure whether the achieved results were on the basis of the time duration because their study did not include a control group without being provided by this intervention.[20] Based on the findings and given the limitations of their research, in our current trial, multiple sessions along with manual therapy were provided to groups. Consequently, a comparison was also carried out to show between groups and within groups results of the current research, which revealed significant improvement in pain reduction within the experimental group.

A study was conducted by Moral OM and co-workers to find out the effectiveness of trigger point dry needling.[22] Even though, the outcomes of the research were not statistically significant, the patients in both groups revealed a mild reduction in pain after each session of dry needling. Now considering this fact, to attain better outcomes in our current study, the control group who was treated with manual therapy was given at least four to five sessions to achieve desirable outcomes. Additionally, for the experimental group, it was observed that patients who had mild to moderate pain also reported a reduction in pain after a single session of dry needling which appeals to the findings that trigger point dry needling is an efficient and effective intervention for managing the symptoms of PPS.

Mason and his co-workers conducted research in 2016, to determine the effects of dry needling while comparing them to stretching and strengthening exercises for treating hamstrings and knee joint functionalities. They concluded that because of the limited time duration and frequency of dry needling, they were not able to find an evocative difference in the experimental and control group. Also, they only used one muscle for dry needling which might have critically affected the procedure of treatment.[34]

Considering the previous research findings, in this current study, the duration for applying dry needling and the frequency for applying dry needling were set according to the standardized procedures and the therapeutic exercises were also carried out for at least fifteen to twenty minutes per session to achieve the desired outcomes. The findings of this current randomized control trial nullify

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the already existing research findings. However, the recommendations given by the researchers justify the current research outcomes.

Espi-Lopez and his co-workers conducted research to determine the effects of trigger point dry needling along with a multimodal therapeutic program in which only a single session of dry needling was given. Their results showed that the difference in intensity of knee pain was 2.3 for the experimental group and 1.8 for the control group. Their results concluded that the inclusion of trigger point dry needling did not make a significant improvement in the experimental group because of limited sessions of trigger point dry needling.[35] Now keeping this limitation in view, in our randomized control trial, multiple sessions of dry needling were given on alternate days, to maximize the effects of treatment and to justify the aims of this research.

Based on the findings of the already existing literature, it might be stated that trigger point dry needling with manual therapy might make a significant difference when included in the rehabilitation of PPS. As yet very inadequate research have been conducted on the finding of the effects of trigger point dry needling, but the majority of the researchers have realized the significance of trigger point dry needling for treating PPSs. The lack of knowledge and awareness among clinicians and patients regarding the field of physiotherapy is still a persistent phenomenon, hence it was a difficult task to find patients specifically suffering from PPS.

In this current randomized controlled trial, patients were not re-assessed in follow-ups, so future researchers are recommended to consider short and long-term follow-ups to have more specific insights into this intervention for PPS. Only a few researchers have provided us with the literature and evidence regarding the interventional management of PPS which has influenced the expertise of the practitioners about the advanced interventions, hence future research in this field might greatly contribute as a guideline for medical practitioners.

CONCLUSION

This current trial concludes that trigger point dry needling is surely an effective treatment approach that can substantially reduce the intensity of pain and can improve functionality in patients suffering from patellofemoral pain syndrome.

DECLARATIONS

Consent to participate: Written consent had been taken from patients. All methods were performed following the relevant guidelines and regulations.
Availability of data and materials: Data will be available on request. The corresponding author will submit all dataset files.
Competing interests: None
Funding: No funding source is involved.
Authors' contributions: All authors read and approved the final manuscript.
CONSORT Guidelines: All methods were performed following the relevant guidelines and regulations.

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