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A Study on Percutaneous Electrical Nerve Stimulation with Open Kinematic Exercises on Gluteus Medius Activation in Patellofemoral Pain Syndrome

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Abstract

Patellofemoral pain accounts for 25-40% of knee pain cases. It is thought that weakness or inadequate activation of gluteus medius muscle while weight-bearing can lead to internal rotation of the femur and consequently lateral tracking of the patella, gradually leading to patellofemoral pain syndrome. Percutaneous Electrical Nerve Stimulation is a novel treatment modality for the management of myofascial pain syndrome, when combined with open kinematic exercises, it helps to improve the strength of a particular muscle. To determine the effects of Percutaneous Electrical Nerve Stimulation with open kinematic exercises on gluteus medius activation in patellofemoral pain syndrome. A study conducted on 30 patients with patellofemoral pain syndrome. All the patients received Percutaneous Electrical Nerve Stimulation, in the myofascial trigger points of the gluteus medius muscle, along with it open kinematic exercises were given targeting the gluteus medius muscle. PENS were given twice a week for 6 weeks. Open kinematic exercises were given 5 days a week for 6 weeks. Paired t – test was used to analyze the statistical difference. The pre - test value of electromyography was (138.11 ± 2.08, $P < 0.0001$) and post - test value was (140.61 ± 1.83, $P < 0.0001$). As for the pain score (NPRS) the pre – test value was (6.67 ± 1.54, $P < 0.0001$) and post - test value was (3.2 ± 1.2, $P < 0.0001$). A significant difference was noted in the gluteus medius activation levels and the pain score with the application of Percutaneous Electrical Nerve Stimulation with open kinematic exercises targeting the gluteus medius muscle. The study concluded that Percutaneous Electrical Nerve Stimulation with open kinematic exercises is effective in the activation of gluteus medius muscle.

Keywords

Percutaneous Electrical Nerve Stimulation, Open kinematic exercise, Patellofemoral pain syndrome, Gluteus medius, Electromyography

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Introduction

Pain behind or near the patella is referred to as patellofemoral pain. In general practice, 11–17% of all knee pain cases involve patellofemoral discomfort, which is common. Although it typically affects physically active people under the age of 40, it can also affect people of all ages and activity levels (Crossley et al., 2016). The assumption behind most treatment strategies is that patellar tracking abnormality and/or malalignment are the causes of Patellofemoral Pain (PFP). As a result, interventions usually concentrate on the joint itself. More recently, it has been understood that the interplay of the lower extremity's segments and joints may have an impact on the patellofemoral joint and, consequently, PFP. Patellofemoral joint mechanics may be impacted, in particular, by aberrant motion of the tibia and femur in the transverse and frontal planes. A systematic review identified 12 published articles evaluating the muscle activation levels associated with Patellofemoral Pain Syndrome (PFPS). A small significant association between PFPS and reduced Glutes medius (GM) activation was identified (Xie et al., 2022).

The muscles of the hip area in people with patellofemoral pain syndrome has an increased occurrence of myofascial trigger points (Karamiani et al., 2022). There have also been studies where trigger points (TrPs) have been shown to affect muscle strength, tension, activation pattern and motor control (Ge et al., 2014). Therefore, it can be assumed that TrPs in the GM may result in changes to the functioning of the muscle. This frontal stability is provided by the ipsilateral GM and contralateral quadratus lumborum in unilateral PFP, preventing hip adduction, which could increase the stress on the patellofemoral joint. In order to effectively manage PFP, it has been suggested that mediolateral pelvic control should be optimized. Therefore, it's possible that concentrating treatment efforts on GM TrPs will result in better PFP rehabilitation.

The kinetic chain is a way to describe the human movement which can be a closed kinematic or an open kinematic chain. Both open and closed kinematic chain exercises have a role in rehabilitation. The biggest advantage of an open kinematic exercise is that it can isolate muscle. In open kinematic exercise the distal segment is allowed to move freely through space (Reed and Bowen, 2008) while movement is restricted to a single joint.

Percutaneous electrical nerve stimulation (PENS), regarded as a type of electro acupuncture, involves administering an electric current through needles conveniently positioned in various body sites. The needle serves as an electrode for the administration of the electricity in this variation of dry needling. PENS have been shown to be an effective method for the relief of pain associated with various musculoskeletal conditions (Fernández-Carnero, 2021). PENS application for pain reduction is comparatively effective when compared to that of TENS (Fernández-Carnero, 2021).

A very limited number of studies have been done with the application of PENS, and it has been used for conditions like low back pain, neck pain and tennis elbow. This is the first study to implicate the application of PENS for patellofemoral pain syndrome. Thus, the objective of this study was to find the effectiveness of percutaneous electrical Nerve Stimulation combined with open kinematic exercises on gluteus medius activation in individuals with patellofemoral pain syndrome.

Methodology

Permission was obtained from the institutional ethical committee (01/012/2022/ISRB/PGSR/SCPT) followed by which the study was conducted. 30 patients with patellofemoral pain syndrome were selected from the physiotherapy outpatient department, Saveetha Medical College and Hospital. The procedure was explained to all the patients, and an informed consent was obtained prior to the study. Patients below 45 years with the presence of active trigger points, a positive Clarke's test and NPRS score ≤ 8 were included in this study. Patients with self-reported knee pathologies, knee abnormalities, any infections, skin conditions, pregnancy and presence of any neurological symptoms were excluded from the study. EMG data were collected and analyzed on the gluteus medius muscle through Maximum Voluntary Isometric Contraction (MVIC) as a baseline measure, along with this NPRS score was also recorded. The NPRS scale has got a high reliability value of 0.9 with a validity of 0.86 to 0.95. The EMG reliability value is 0.87 – 0.94 which depicts high reliability and EMG has got a validity score of 0.94. For the application of PENS, patients were positioned in the side lying position, draping was done and the area to be needled was exposed and sterilized. Myofascial trigger points were located on the gluteus medius muscle, followed by which the needle size was selected based on the muscle bulk of the patient. Patients were given Percutaneous Electrical Nerve Stimulation twice a week for 6 weeks. Open Kinematic exercises (clamshell with 30 degrees hip flexion, side lying hip abduction) (Distefano et al., 2009) were prescribed to the patient 5 days a week for 6 weeks. It consisted of 15 repetitions and 3 sets with a 10 second hold period and 1 minute of rest for every 5 sets (Ramalingam et al., 2023). The study's total duration was 6 weeks after which EMG data was collected and analyzed along with NPRS score. Paired t-test was used to compare the mean difference between the pre and post-test values of the EMG and the NPRS score.

PARAMETERS:

PENS
• Needle size: 0.40 × 0.40, 0.60 mm • Frequency: 15/30 Hz • Duration: 10 min

Results

The data collected was tabulated and analyzed. EMG (% MVIC) and NPRS data were measured, paired t- test was used to analyze the significant changes between the pre-test and the post-test measurements. From the values it can be inferred that the NPRS scores showed extremely significant improvements, while the EMG value showed mild levels of activation (Table 2 and 3).

Table 1: Demographic data of the participants

Analysis	Average	Total
Age	25 - 35	6
	36 - 45	24

Gender	Male	6
	Female	26

Table 2: Comparison of pre - test and post - test values for EMG

		Mean	SD	T value	P value
EMG (%MVIC)	Pre	138.11	2.08	10.8351	< 0.0001
	Post	140.61	1.83		

EMG: Electromyography, % MVIC: Percent Maximal Voluntary Isometric Contraction

Table 3: Comparison of pre - test and post - test values for NPRS

		Mean	SD	T value	P value
NPRS	Pre	6.67	1.54	14.64	< 0.0001
	Post	3.2	1.2		

NPRS: Numerical Pain Rating Scale

Discussion

The current study is about the effectiveness of PENS with open kinematic exercises on gluteus medius activation in individuals with patellofemoral pain syndrome. NPRS and EMG are used as an outcome measure for the assessment of pain and to note the muscle activation levels. The mean value of pre -test was (EMG: 138.11, NPRS: 6.67) and the post-test values were (EMG: 140.61, NPRS: 3.2). The differences between the pre – test and the post – test values of the NPRS are quite significant, while the EMG values show a mild increase in the activation levels of the gluteus medius. Though the EMG value is statistically significant, only slight levels of activation were seen in the subjects, depicting low levels of clinical significance.

A study conducted by (de Sire et al.,2021), they described the various applications of PENS and its role in the rehabilitation management, they also stated the application of PENS as a promising conservative and mini-invasive intervention to manage chronic pain conditions such as low back pain, chronic knee pain and tension headaches. PENS application was considered as an effective and safe treatment option for pain reduction. In the current study PENS has been used as a therapeutic intervention to treat pain, and our studies reported a statistically significant difference in the NPRS score.

The prevalence of myofascial trigger point in the gluteus medius was significantly increased in patients with patellofemoral pain syndrome than in healthy individuals (Samani et al., 2020). In this study when the subjects were assessed for the trigger points, almost 95 % of the

subjects had a minimum presence of two to three trigger points. There was a study done previously to this which stated that 25% to 50% of patients with patellofemoral pain syndrome had reduced strength in the abductor and external rotator muscles, and they concluded that this weakness made patients with patellofemoral pain syndrome more likely to develop myofascial trigger points (Roach et al., 2013). PENS were used to address the trigger points in the current study, along with which open kinematic exercises were prescribed to the patients to improve their muscle strength.

Garcia-de-Miguel et al. (2020) The study compared the short-term effects of PENS and dry needling in subjects with unilateral neck pain and active myofascial trigger points. When the results were compared PENS showed greater improvements in the mechanosensitivity and disability than dry needling. Similar results were obtained in this study, application of PENS for patellofemoral pain syndrome showed significant improvement in the pain and minimal improvement in the muscle activation levels. Long term follow up is needed for future studies to know the long terms effects of this intervention.

A five year long prospective randomized study was performed to find the effectiveness of open and closed kinetic chain exercises in individuals with patellofemoral pain syndrome (Witvrouw et al.,2004). This was the only study till date which has explored the effectiveness of open and closed kinetic chain exercises in subjects with PFPS. According to that study both open and closed kinetic chain exercise interventions demonstrated a good subjective and an overall functional outcome. In this study we have used the open kinetic exercises, since we are concentrating on a single muscle, the gluteus medius. Closed kinetic exercises act on multiple joint segments, creating movements in a greater number of muscles.

There are a very limited number of studies on the application of PENS. To date PENS technique has been defined as a “Rapid emerging field” by the National Institute for Health and Care Excellence (NICE) guidelines. Further investigations should be conducted with a bigger sample size and it can also be gender specific. The duration of the current study was 6 weeks, future studies can be done with a longer period, to see if these results sustain for a long time. A control group can be included in the future studies to confirm the efficiency of PENS in the management of various pain conditions.

Conclusion

From the findings of the current study, it can be determined that Percutaneous Electrical Nerve Stimulation with open kinematic exercise is slightly effective in the activation of the gluteus medius muscle. The findings suggested that the intervention was extremely significant in the reduction of pain in subjects with patellofemoral pain syndrome.

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References

Barton, C. J., Lack, S., Malliaras, P., & Morrissey, D. (2013). Gluteal muscle activity and patellofemoral pain syndrome: A systematic review. *British Journal of Sports Medicine*, *47*(4), 207–214. https://doi.org/10.1136/bjsports-2012-090953

Crossley, K. M., Callaghan, M. J., & van Linschoten, R. (2016). Patellofemoral pain. *British Journal of Sports Medicine*, *50*(4), 247–250.

de Sire, A., Ammendolia, A., Lippi, L., Farì, G., Cisari, C., & Invernizzi, M. (2021). Percutaneous electrical nerve stimulation (PENS) as a rehabilitation approach for reducing mixed chronic pain in patients with musculoskeletal disorders. *Applied Sciences*, *11*(9), 4257. https://doi.org/10.3390/app11094257

Distefano, L. J., Blackburn, J. T., Marshall, S. W., & Padua, D. A. (2009). Gluteal muscle activation during common therapeutic exercises. *Journal of Orthopaedic & Sports Physical Therapy*, *39*(7), 532–540.

Fernández-Carnero, J. (2021). Effectiveness of dry needling with percutaneous electrical nerve stimulation of high frequency versus low frequency in patients with myofascial neck pain. *Pain Physician*, *24*, 135–143.

Garcia-de-Miguel, S., Pecos-Martin, D., Larroca-Sanz, T., Sanz-de-Vicente, B., Garcia-Montes, L., Fernandez-Matias, R., & Gallego-Izquierdo, T. (2020). Short-term effects of PENS versus dry needling in subjects with unilateral mechanical neck pain and active myofascial trigger points in levator scapulae muscle: A randomized controlled trial. *Journal of Clinical Medicine*, *9*(6), 1665.

Ge, H. Y., Monterde, S., Graven-Nielsen, T., & Arendt-Nielsen, L. (2014). Latent myofascial trigger points are associated with an increased intramuscular electromyographic activity during synergistic muscle activation. *The Journal of Pain*, *15*(2), 181–187.

Karamiani, F., Mostamand, J., Rahimi, A., & Nasirian, M. (2022). The effect of gluteus medius dry needling on pain and physical function of non-athlete women with unilateral patellofemoral pain syndrome: A double-blind randomized clinical trial. *Journal of Bodywork and Movement Therapies*, *30*, 23–29.

Loudon, J. K. (2016). Biomechanics and pathomechanics of the patellofemoral joint. *International Journal of Sports Physical Therapy*, *11*(6), 820.

Morihisa, R., Eskew, J., McNamara, A., & Young, J. (2016). Dry needling in subjects with muscular trigger points in the lower quarter: A systematic review. *International Journal of Sports Physical Therapy*, *11*(1), 1.

Payne, K., Payne, J., & Larkin, T. A. (2020). Patellofemoral pain syndrome and pain severity is associated with asymmetry of gluteus medius muscle activation measured via ultrasound. *American Journal of Physical Medicine & Rehabilitation*, *99*(7), 595–601. https://doi.org/10.1097/phm.0000000000001367

Powers, C. M. (2003). The influence of altered lower-extremity kinematics on patellofemoral joint dysfunction: A theoretical perspective. *Journal of Orthopaedic & Sports Physical Therapy*, *33*(11), 639–646.

Rainoldi, A., Melchiorri, G., & Caruso, I. (2004). A method for positioning electrodes during surface EMG recordings in lower limb muscles. *Journal of Neuroscience Methods*, *134*(1), 37–43.

Ramalingam, V., Jagatheesan, A., & Suganthirababu, P. (Eds.). (2023). *Proceedings of International Physiotherapy Conference - Stride'23*. *International Journal of Physiotherapy and Occupational Therapy*, 1–143. https://ijpot.com/conference.html

Reed, J., & Bowen, J. D. (2008). Principles of sports rehabilitation. In *The Sports Medicine Resource Manual* (1st ed., pp. 431–436). Saunders.

Reiman, M. P., Bolgla, L. A., & Loudon, J. K. (2012). A literature review of studies evaluating gluteus maximus and gluteus medius activation during rehabilitation exercises. *Physiotherapy Theory and Practice*, *28*(4), 257–268.

Roach, S., Sorenson, E., Headley, B., & San Juan, J. G. (2013). Prevalence of myofascial trigger points in the hip in patellofemoral pain. *Archives of Physical Medicine and Rehabilitation*, *94*(3), 522–526.

Rozenfeld, E., Finestone, A. S., Moran, U., Damri, E., & Kalichman, L. (2020). The prevalence of myofascial trigger points in hip and thigh areas in anterior knee pain patients. *Journal of Bodywork and Movement Therapies*, *24*(1), 31–38.

Samani, M., Ghaffarinejad, F., Abolahrari-Shirazi, S., Khodadadi, T., & Roshan, F. (2020). Prevalence and sensitivity of trigger points in lumbo-pelvic-hip muscles in patients with patellofemoral pain syndrome. *Journal of Bodywork and Movement Therapies, 24*(1), 126–130. https://doi.org/10.1016/j.jbmt.2019.10.012

Witvrouw, E., Danneels, L., Van Tiggelen, D., Willems, T. M., & Cambier, D. (2004). Open versus closed kinetic chain exercises in patellofemoral pain: A 5-year prospective randomized study. *The American Journal of Sports Medicine*, *32*(5), 1122–1130.

Xie, P. P., István, B., & Liang, M. (2022). Sex-specific differences in biomechanics among runners: A systematic review with meta-analysis. *Frontiers in Physiology*, *13*, 994076. https://doi.org/10.3389/fphys.2022.994076

Zarei, H., Bervis, S., Piroozi, S., & Motealleh, A. (2020). Added value of gluteus medius and quadratus lumborum dry needling in improving knee pain and function in female athletes with patellofemoral pain syndrome: A randomized clinical trial. *Archives of Physical Medicine and Rehabilitation*, *101*(2), 265–274.