Original Article

Effect of Pain Neuroscience Education with Conventional Physiotherapy via Telerehabilitation on Pain Catastrophizing and Function in Patients with Osteoarthritis Knee: A Randomized Controlled Trial

Hiral Manohar Supe, Sanket S. Mungikar, Goutami A. Katage, Kapil A. Garg, Surendra Kiran Wani

Department of Musculoskeletal Physiotherapy, MGM Institute of Physiotherapy, Aurangabad, Maharashtra, India

Abstract

Aim: By explaining to the patient the biological processes underneath their pain condition, pain neuroscience education (PNE) is a form of educational intervention that aims to relieve pain and impairment. **Materials and Methods:** Patients with knee osteoarthritis (OA) referred to outpatient physiotherapy clinic in India during August 2021 to June 2022 were asked to participate. Out of the eligible patients, 35 were randomly assigned to PNE group and 35 to the control group. Self-reports of Pain Catastrophizing Scale (PCS), Patient Specific Function Scale (PSFS), and Numerical Pain Rating Scale (NPRS) were recorded at baseline (T1) and at 2 weeks (T2). **Results:** After 2 weeks of follow-up, all the three outcome measures were found to be significant in the PNE group. The results of the unpaired *t*-test revealed statistically significant result posttest for PCS (mean difference 11.4) and NPRS (mean difference 1.20). There was no mean difference found in the patient function (PSFS) between groups. **Conclusion:** The results suggest that adding a program of PNE to conventional physiotherapy exercises led to a greater reduction in pain catastrophization, patient-specific function, and pain intensity rather than conventional physiotherapy alone in patients with knee OA at 2 weeks' follow-up.

Keywords: *Knee osteoarthritis, pain catastrophizing, pain neuroscience education, patient function, physiotherapy, telerehabilitation*

Submitted: 14-Feb-2023
Accepted: 04-May-2023
Published: 18-Sep-2023

Introduction

Osteoarthritis (OA) is the most prevalent form of arthritis and is a major cause of musculoskeletal pain, functional impairment, and decreased independence in older people worldwide.[1] The prevalence for OA in India is approximately 41% of the elderly population which is really a cause of concern.[2]

International guidelines that are thorough in their methodology strongly advise using nonpharmacological methods as the first line of treatment for knee OA.[3] First-line strategies to manage the symptoms of these patients are physical exercise, patient education, and weight reduction.[4] The experience of pain in people with OA of the knee is thought to be influenced by a combination of structural changes to the knee, psychosocial factors, and pain neurophysiology.[5] Despite the fact that OA patients frequently complain of pain, the medical professionals have scare knowledge regarding the causes, mechanisms, and treatments.[6]

Pain neuroscience education (PNE) can be used in conjunction with physiotherapy to break pain memories triggered by the movement through graded exposure to exercise and reduce nervous system sensitivity.[7] A Systematic Review of the Effectiveness of PNE on Pain and Psychosocial Variables for OA found that there was strong evidence of improvement for the groups treated with PNE, while additional research on the subject is needed.[8]

Access this article online

Quick Response Code:

Website: https://journals.lww.com/jomh

DOI: 10.4103/jmh.jmh_33_23

Address for correspondence: Dr. Sanket S. Mungikar, Department of Musculoskeletal Physiotherapy, M. G. M. Institute of Physiotherapy, N-6 CIDCO, Aurangabad, Maharashtra, India.
E-mail: mungikarphysio@gmail.com

How to cite this article: Supe HM, Mungikar SS, Katage GA, Garg KA, Wani SK. Effect of pain neuroscience education with conventional physiotherapy via telerehabilitation on pain catastrophizing and function in patients with osteoarthritis knee: A randomized controlled trial. J Mid-life Health 2023;14:123-9.

Moreover, PNE trials mostly targeted individuals with chronic low back pain, chronic fatigue syndrome,[9] and fibromyalgia,[10] but not OA of knee, which is one of the most prevalent chronic musculoskeletal conditions. To increase access to more specialized physiotherapy for musculoskeletal problems, novel solutions are required.[11]

Telerehabilitation strategies are used to assess patients on the orthopedic waiting list[12] and connect physical therapists with therapeutic resources for home exercise programming in the rural areas.[13] More substantial randomized controlled trials (RCTs) are required to further telerehabilitation for musculoskeletal physical therapy.[11]

Surprisingly, blended learning techniques for PNE have developed in this digital world. Blended learning is a type of formal learning program which combines online and face to face instruction to provide a more efficient way to transmit the information in terms of both time and money.[14] Due to its positive effects on the timing and cost of therapy, this type of instructional technique has been employed in our study.

This study aims to investigate the combined effects of PNE with conventional physiotherapy through telerehabilitation on pain catastrophizing and patient function and pain intensity in patients with OA. The secondary aim was to assess patient's perception of PNE.

Materials and Methods

This study was designed as a randomized, controlled, double-blind study. Data collection was carried out between August 2021 and June 2022 at a tertiary health care center. The intervention described below is reported using TIDieR checklist.

Figure 1 illustrates a modified CONSORT flow diagram for individual RCTs of nonpharmacologic therapy.[15] Patients experiencing knee pain were approached, out of which 78 patients were screened for eligibility. Eight were excluded from the study because they could not fulfill the inclusion criteria. Ultimately, seventy patients were included in our study. Patients were then randomly allocated into two groups: Group 1 (PNE group) and Group 2 (Control group). All participants were made aware of the methods and evaluations that would be used in the study in advance. The consent form was signed by those who agreed to participate. Participants in PNE group received PNE with conventional exercise and participants in the control group received only conventional physiotherapy exercise.

Participants were included in the study if they were medically diagnosed OA patients who matched the requirements of American College of Rheumatology Criteria, which is used to diagnose OA of knee joint is the presence of pain in knee, including 3 of the six components which consists of age more than 50 years, presence of crepitus on active motion, <30 min of morning stiffness, bony tenderness, bony overgrowth, and no palpable warmth of synovium. Participants were excluded if they had pain due to tumor or infection underwent any knee surgery, co-existing inflammatory, metabolic, neurological disease, cognitive impairments, and subjects with history of trauma. All the outcome measures were taken at baseline and at the end of 2 weeks posttreatment session.

Intervention

Conventional physiotherapy exercises were presented to both groups in the first in-person session, and each participant was told to follow the exercise plan every day. For the PNE, patient details were taken prior and a group of 6–8 people were assigned and an online session of PNE through telerehabilitation was taken.

Pain neuroscience education

The participants attended two sessions of PNE through telerehabilitation. To ensure uniform delivery of the training, each participant attended a single training regimen. This educational session was provided only by one therapist to all the participants. The online session was well planned before it was incorporated on the participants. Following baseline testing, Session 1 began which lasted approximately for 30 min. Two weeks after session 1, session 2 was conducted. It began with a PNE session that lasted around 20 min and ended with follow-up testing. This telerehabilitation session included a verbal explanation with a visual presentation on power point.

Educational content of the session included pictures, examples, and metaphors for explaining pain. The metaphorical alarm system was used to describe the nervous system's sensitivity. The purpose of this session was to establish rapport with the participants, highlight the maladaptive nature of chronic pain, emphasize the significance of pain's role in tissue protection, and improve the subjects' understanding of factors that influence pain production. The protocol for PNE is described in detail in Appendix A. Reviewing the information from the first session's topic and responding to participant-generated questions took up most of the second session. At the conclusion of the second educational session, participants' opinions of the educational intervention were evaluated using a self-report survey with eight multiple-choice items.

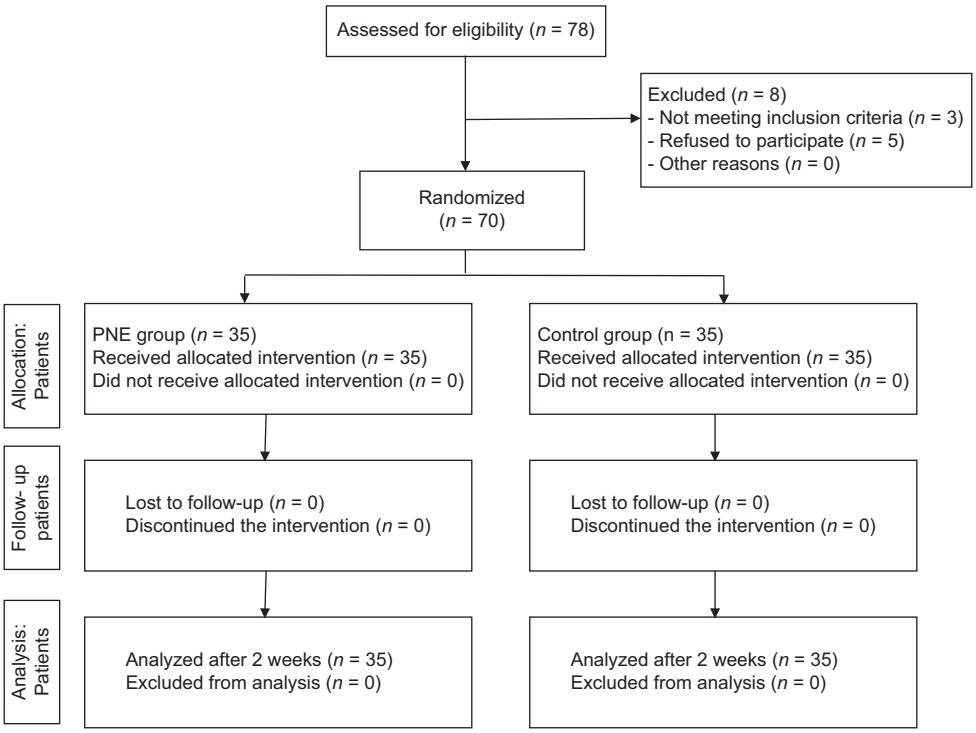

Figure 1: CONSORT diagram for patient allocation and retention

Conventional physiotherapy exercise

The exercise program used in this study is a multimodal program which included strengthening and stretching exercise. In the first session, exercise was demonstrated to the participants, and then, the participant performed the exercise independently. The physiotherapist corrected each participant individually as required to ensure correct technique and confirmed that the patients are confident to do the exercise alone at home every day for 2 weeks. Each exercise was instructed to do twice a day with ten repetitions for each exercise. The exercise protocol includes miniwall squats, towel-assisted knee flexion and extension, short arc quadriceps, heel raises, sitting hamstring stretching, and calf stretch.

Outcome measures

Pain Catastrophizing Scale

Pain catastrophizing is characterized by a relative inability to prevent or inhibit pain-related thoughts before, during, or after a painful occurrence. This is in addition to feeling helpless in the presence of pain and having a tendency to overstate the threat value of a pain signal.[16] It is a 13-item Likert scale relating to catastrophic thought process about the pain. Higher scores (range, 0–52) indicate more catastrophic interpretation of pain.

Patient-Specific Function Scale

It is a self-report function outcome measure that can be applied to patients with different levels of independence.[12] The scale has been demonstrated to have strong test-retest reliability in cases of both common lower back pain and knee dysfunction.[17]

Numerical Pain Rating Scale

Pain intensity was evaluated using the Numerical Pain Rating Scale (NPRS). The 11-point numeric scale ranges from 0 to 10 with 0 representing no pain and 10 representing the worst pain. The participants were asked to indicate the numeric value on the scale that best describes their intensity of pain. This outcome measure has high test-retest reliability and validity.[18]

Sample size

The required sample size was calculated in advance of the trial using G*Power software version 3.1.9.7 (Keil, Germany) assuming a power of 80% and a significance level of 5%. All patients who were eligible for participation and met the inclusion criteria were included.

Randomization

Allocation was achieved through concealment and was carried out using opaque-sealed envelopes. A 1:1 allocation ratio was used to generate sequentially numbered, opaque envelopes that included coded treatment assignment cards, and they were then randomly mixed. Randomization was done at the end of the visit. If the patient met the inclusion criteria, the assessor opened the envelopes in a specific order while the patient was present, ensuring a random distribution of patients.

Blinding

The study was a double-blinded study. After the randomization into two study groups, the participants were evaluated by a blinded assessor. All the participants were blinded to the interventions which they received after which they underwent 2 weeks of treatment with the therapist.

Statistical analysis

Statistical analysis was performed using IBM SPSS version 24.0 (Statistical Software Package for the Social Sciences, IBM, United States). For categorical data, frequency distribution was estimated. To evaluate the appropriateness of the randomization, baseline demographic data [Table 1] were compared between the treatment groups using the Shapiro–Wilk test for the continuous data and Chi-square tests of independence for the categorical data. All the data were described using means and standard deviations. Intention to treat analysis was performed. The analysis for baseline and post 2 weeks score difference for NPRS, Pain Catastrophizing Scale (PCS) and Patient Specific Function Scale (PSFS) in PNE group and control group were done by paired *t*-test and similarly analysis for posttreatment differences scores between the groups for NPRS, PCS, and PSFS was done by independent *t*-test. Descriptive analysis for the questionnaire of perception of PNE was done in a tabular format. Using a two-tailed test with a 95% confidence interval (CI), the alpha level for all analyses was predetermined at 0.05.

Results

A total of 70 participants completed their assigned treatment program and posttreatment evaluation. Baseline characteristics are presented in Table 1, Group 1 (PNE n = 35) mean age 58.34 ± 5.80, Group 2 (Control n = 35) mean age 58.51 ± 5.66. Out of 70 participants, 91% of subjects were female. Age, gender, involved side, and duration of knee pain are shown in Table 1, there was no significant differences detected between the groups in terms of age (P = 0.99), duration (P = 0.97), and involved side of knee OA (P = 0.68). The outcome measures pain intensity; pain catastrophization and patient function were found similar at baseline.

Table 1: Demographic data and outcome measures at baseline

Variables	PNE group (n=35)*	Control group (n=35)*	P
Age (years)	58.34±5.80	58.51±5.66	0.99[I]
Duration (years)	4.01±1.67	3.69±1.75	0.97[I]
Involved side (right/left/both)	11/12/12	11/15/9	0.68[‡]
Male/female	4/31	2/33	0.39[‡]
NPRS	6.71±1.18	5.91±1.57	0.32[I]
PCS	22.09±6.09	22.85±6.77	0.32[I]
PSFS	6.21±1.04	5.91±1.57	0.99[I]

*Values are mean±SD unless otherwise indicated, [I]Chi-square tests, [II]Independent-sample *t*-tests. NPRS: Numeric Pain Rating Scale, PCS: Pain Catastrophizing Scale, PSFS: Patient Specific Function Scale, SD: Standard deviation, PNE: Pain neuroscience education

All of the three outcome measures were significantly greater after giving PNE via telerehabilitation with exercise at 2 weeks with respect to within group comparison of PNE group. With regard to the Numeric Pain Rating Scale, the mean difference was 2.51; 95% CI, 2.04–2.98; $P < 0.0001$. There was significantly smaller effect on the function of subjects with a mean difference of −1.59; 95% CI, −1.95 to −1.22; $P < 0.0001$. Within group comparison of the control group showed significantly greater effects after doing exercise in NPRS and function, respectively. It was remarkable that there was no significant change found in the PCS post 2 weeks of the intervention with a mean difference of −0.714; 95% CI, −2.28–0.85; P = 0.36.

Out of the three outcome measures, NPRS and PCS showed significant difference between the groups ($P < 0.05$). The results of the unpaired *t*-test [Table 2] revealed statistical significant result posttest for the group factor NPRS (mean difference 1.2, 95% CI, and 0.6–1.7) and PCS (mean difference 11.4, 95% CI, 9.4–13.5). There was no significant change found between groups in the patient function post 2 weeks of the intervention with a mean difference of −0.13.

The self-report questionnaire for perception of PNE consisted of eight questions which are enumerated in detail [Table 3]. A favorable response to the educational session was consistently recorded by the subjects. A total of 35 participants completed the educational session. Surprisingly, all the subjects found the session interesting and agreed to recommend the information about pain to a friend. Only 2% of participants found that educational session was very difficult to understand and believed that it would not help the people who are in pain. There were no adverse events discovered in either group.

Discussion

Although the chronic musculoskeletal pain is prevalent and has an impact on elderly people, there is a very limited research on non-pharmacological treatments for the management of pain this population. Our study aimed at investigating the effects of PNE with conventional physiotherapy via telerehabilitation in patients with osteoarthritis knee. The findings show that patients with osteoarthritis who receive PNE in addition

Table 2: Comparison of between groups for Numerical Pain Rating Scale, Pain Catastrophizing Scale and Patient Specific Function Scale

Outcome measures	Pre[I]			Post 2 weeks[I]		
	PNE group	Control group	*P*	PNE group	Control group	*P*
NPRS	6.71±1.18	5.91±1.57	0.0208	3.17±1.05	4.4±1.24	<0.0001*
PCS	22.09±6.09	22.85±6.77	0.9665	10.66±3.46	22.14±5.01	<0.0001*
PSFS	6.21±1.04	5.91±1.57	0.212	4.62±1.11	4.48±1.080	0.610

*Difference $P<0.05$, [I]Values are mean±SD. NPRS: Numeric Pain Rating Scale, PCS: Pain Catastrophizing Scale, PSFS: Patient Specific Function Scale, SD: Standard deviation, PNE: Pain neuroscience education

Table 3: Descriptive analysis of questionnaire for perception of pain neuroscience education

Questions	Answers	Total 35 subjects
1. The information presented in the educational session was-	a. Very easy to understand	13
	b. Easy to understand	10
	c. Difficult to understand	11
	d. Very difficult to understand	1
2. The information presented in the educational session was-	a. Interesting	35
	b. Boring	0
3. The information presented in the session was-	a. Very clear	9
	b. Clear	17
	c. Somewhat clear	9
	d. Unclear	0
4. Which of the following best describes the your learning during this experience-	a. I learned new and helpful things	21
	b. I already knew most of the information	14
	c. The information was not helpful	0
5. The education session was-	a. Too long	10
	b. Just right	21
	c. Too short	4
6. Which of the following best describes your feelings about the content delivered in the educational sessions?	a. I believed most of it	5
	b. I believed some of it	12
	c. I believed none of it	18
7. The presented information is-	a. Likely to help people who are in pain	34
	b. Unlikely to help people who are pain	1
8. Based on the information I would-	a. Recommends the information to a friend who is in pain	35
	b. Not recommends this information to a friend who is in pain	0

PNE: Pain neuroscience education

to conventional therapy experience noticeably higher improvements in pain catastrophizing, patient function, and pain intensity. Over a course of short term follow-up period of 2 weeks these effects were maintained.

The pain Catastrophization was found to be significantly higher in the PNE group than the conventional exercises alone. A key component of PNE is Reconceptualizing pain, which aims to alter how patients experience their pain. This implies that even though they still experience pain they think differently about it, equating it to sensitization of the nervous system versus the health of the tissue. According to APH Karlsen *et al*, a variety of therapies, including surgery, physiotherapy, and even pharmaceuticals, can significantly reduce pain catastrophizing.[19] Another study done by Y Sharifzadeh *et al* claimed that PNE can also lower rates of opioid prescription, which is another advantage that can improve the psychological factors and reduce medical expenses.[20] Additionally, this reconceptualization conveys the idea that, "despite the pain," it is important to move, exercise, engage, and carry on with daily activities. Any patient's healthcare status can be changed by adopting this behavior. Pain neuroscience education is used to help patients comprehend the underlying physiology of pain and decrease the threat of pain.[21] In patients with non-specific chronic low back pain, Moseley *et al*. discovered a significant reduction in catastrophizing views on the PCS following intense neurophysiology education on pai.[22] A study done by R V Briani *et al* and M Hurley *et al* stated that there are psychological benefits of exercise in patients with knee osteoarthritis.[23,24] Our study supports well to the above statement as we found superior benefits of pain neuroscience education and conventional exercise on pain Catastrophization. By extending the education, therapy, and home assignment, pain catastrophizing may be even more minimized. And hence we suggest future studies to evaluate the long term effects for the same.

It was found that the patient function in both the group improved over time. The possible reason given by Louw *et al*, A Malfliet *et al*, J Nijs *et al* was that Patients perceive their pain differently, they experience less fear and Catastrophization of pain, and as a result, they engage in more activities and movements.[25-27] Pain neuroscience education may alter how people think, which could lead to changes in both the quantity and quality of movements. Surprisingly it was observed there was no significant difference found between the PNE group and conventional group for patient specific

function scale. We found one study published by walti *et al* supporting our results which concluded that there was no significant difference found on the PSFS for disability.[28] One of our goal was also to add literature on patient specific function as there is abundant literature on condition specific outcome measure and but literature on patient specific function scale is scarce. Our results with respect to patient function were clinically significant but statistically insignificant.

According to J Nijs *et al*, the objective of the pain neuroscience education process is to impart knowledge to patients so they can comprehend their pain and develop coping mechanisms, reduce false beliefs and difficulties related to pain.[29] The results of our study suggest that there was a significant difference found between groups for pain intensity. The best-evidence recommendations for treating people with chronic pain are consistent with the combination of neuroscience education and physical exercise.[30,31] Greater baseline pain intensity and psychological distress led to somewhat higher post-intervention effects of PNE on pain intensity.[32] Evidence supporting PNE having a statistically significant, small to moderate effect on pain intensity in the post intervention stage was generally of low quality. There were no adverse events reported, indicating the safety of PNE

A study on the viability of using PNE, a promising intervention with impact in older participants, was published by Rufa *et al*. This study was among the first to look at how well patients responded to PNE and how they accepted it, and it gave important details about how older persons felt about it.[33] In our study we applied similar principles and found out that our subjects reported a positive response with the educational session. Total of 35 subjects attended pain neuroscience education. Twenty-one patients reported that the information they learned was new and helpful for them and the length of the session was just right. The way that education is perceived matters more since it can affect how PNE works and how well an intervention is implemented. One study done by MW vanIttersum *et al* performed PNE in written format and found no effects were observed in pain catastrophizing in fibromyalgia patients.[34] According to Robinson *et al*., students who considered the education confusing and irrelevant are unlikely to rethink how they perceive pain, making the education less effective.[35] The participants in our study thought that the telerehabilitation way of delivery was very clear and that the information is likely to benefit those who are in pain.

Strength and limitation

The strength of the study is that the study is a double-blinded RCT which is largely considered while assessing health-care service effectiveness. Few potential limitations also exist in our study. First, after a 2-week follow-up period, the impact of the therapies was not evaluated. Second, no information about the participants' baseline education level was recorded. Third, the therapist was not blinded to treatment allocated to them, but due to the nature of the treatment (i.e., patient education), blinding the therapist was not possible. Future research should look at how PNE affects function in various types of chronic musculoskeletal pain. More qualitative study on PNE is required.

Conclusion

The findings suggest that adding a program of PNE delivered through telerehabilitation with conventional physiotherapy led to a significant reduction in pain catastrophization, knee function, and pain intensity rather than conventional physiotherapy alone in patients with knee OA at 2 weeks' follow-up.

Acknowledgments

The MGM Institute of Physiotherapy's principal and professor are sincerely appreciated by the authors for their professional and scholarly knowledge, support, and involvement in this work.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Cross M, Smith E, Hoy D, Nolte S, Ackerman I, Fransen M, *et al.* The global burden of hip and knee osteoarthritis: Estimates from the global burden of disease 2010 study. Ann Rheum Dis 2014;73:1323-30.
2. Singh AK, Kalaivani M, Krishnan A, Aggarwal PK, Gupta SK. Prevalence of osteoarthritis of knee among elderly persons in urban slums using American College of Rheumatology (ACR) criteria. J Clin Diagn Res 2014;8:C09-11.
3. Fernandes L, Hagen KB, Bijlsma JW, Andreassen O, Christensen P, Conaghan PG, *et al.* EULAR recommendations for the non-pharmacological core management of hip and knee osteoarthritis. Ann Rheum Dis 2013;72:1125-35.
4. Brosseau L, Taki J, Desjardins B, Thevenot O, Fransen M, Wells GA, *et al.* The Ottawa panel clinical practice guidelines for the management of knee osteoarthritis. Part one: Introduction, and mind-body exercise programs. Clin Rehabil 2017;31:582-95.
5. Moseley GL. Reconceptualising pain acording to modern pain sciences. Phys Ther Rev 2007;12:169-78.
6. Lee YC, Nassikas NJ, Clauw DJ. The role of the central nervous system in the generation and maintenance of chronic pain in rheumatoid arthritis, osteoarthritis and fibromyalgia. Arthritis Res Ther 2011;13:211.
7. Nijs J, Lluch Girbés E, Lundberg M, Malfliet A, Sterling M. Exercise therapy for chronic musculoskeletal pain: Innovation by altering pain memories. Man Ther 2015;20:216-20.

8. Moseley GL. Joining forces – Combining cognition-targeted motor control training with group or individual pain physiology education: A successful treatment for chronic low back pain. J Man Manip Ther 2003;11:88-94.
9. Meeus M, Nijs J, Van Oosterwijck J, Van Alsenoy V, Truijen S. Pain physiology education improves pain beliefs in patients with chronic fatigue syndrome compared with pacing and self-management education: A double-blind randomized controlled trial. Arch Phys Med Rehabil 2010;91:1153-9.
10. Van Oosterwijck J, Meeus M, Paul L, De Schryver M, Pascal A, Lambrecht L, *et al.* Pain physiology education improves health status and endogenous pain inhibition in fibromyalgia: A double-blind randomized controlled trial. Clin J Pain 2013;29:873-82.
11. Grona SL, Bath B, Busch A, Rotter T, Trask C, Harrison E. Use of videoconferencing for physical therapy in people with musculoskeletal conditions: A systematic review. J Telemed Telecare 2018;24:341-55.
12. Grona SL, Bath B, Busch A, Rotter T, Trask C, Harrison E. Use of videoconferencing for physical therapy in people with musculoskeletal conditions: A systematic review. Journal of Telemedicine and Telecare 2018;24:341-55.
13. Malfliet A, Kregel J, Meeus M, Roussel N, Danneels L, Cagnie B, *et al.* Blended-learning pain neuroscience education for people with chronic spinal pain: Randomized controlled multicenter trial. Phys Ther 2018;98:357-68.
14. Boutron I, Altman DG, Moher D, Schulz KF, Ravaud P, CONSORT NPT Group. CONSORT statement for randomized trials of nonpharmacologic treatments: A 2017 update and a CONSORT extension for nonpharmacologic trial abstracts. Ann Intern Med 2017;167:40-7.
15. Quartana PJ, Campbell CM, Edwards RR. Pain catastrophizing: A critical review. Expert Rev Neurother 2009;9:745-58.
16. Horn KK, Jennings S, Richardson G, Vliet DV, Hefford C, Abbott JH. The patient-specific functional scale: Psychometrics, clinimetrics, and application as a clinical outcome measure. J Orthop Sports Phys Ther 2012;42:30-42.
17. Chatman AB, Hyams SP, Neel JM, Binkley JM, Stratford PW, Schomberg A, *et al.* The patient-specific functional scale: Measurement properties in patients with knee dysfunction. Phys Ther 1997;77:820-9.
18. Ferraz MB, Quaresma MR, Aquino LR, Atra E, Tugwell P, Goldsmith CH. Reliability of pain scales in the assessment of literate and illiterate patients with rheumatoid arthritis. J Rheumatol 1990;17:1022-4.
19. Karlsen AP, Wetterslev M, Hansen SE, Hansen MS, Mathiesen O, Dahl JB. Postoperative pain treatment after total knee arthroplasty: A systematic review. PLoS One 2017;12:e0173107.
20. Sharifzadeh Y, Kao MC, Sturgeon JA, Rico TJ, Mackey S, Darnall BD. Pain Catastrophizing moderates relationships between pain intensity and opioid prescription: Non-linear sex differences revealed using a learning health system. Anesthesiology 2017;127:136-46.
21. Butler DS, Moseley GL. Explain Pain. 2nd ed. Adelaide, SA, Australia; Noigroup Publications; 2013.
22. Moseley GL, Nicholas MK, Hodges PW. A randomized controlled trial of intensive neurophysiology education in chronic low back pain. The Clinical Journal of Pain 2004;20:324-30.
23. Briani RV, *et al*. What interventions can improve quality of life or psychosocial factors of individuals with knee osteoarthritis? A systematic review with meta-analysis of primary outcomes from randomised controlled trials. Br J Sports Med 2018;52:1031.
24. Hurley M, *et al*. Exercise interventions and patient beliefs for people with hip, knee or hip and knee osteoarthritis: A mixed methods review. Cochrane Database Syst Rev 2018;4:Cd010842.
25. Louw A, Zimney K, Puentedura EJ, Diener I. The efficacy of pain neuroscience education on musculoskeletal pain: A systematic review of the literature. Physiotherapy Theory and Practice 2016;32:332-55.
26. Malfliet A, Kregel J, Coppieters I, De Pauw R, Meeus M, Roussel N, Cagnie B, Danneels L, Nijs J. Effect of pain neuroscience education combined with cognition-targeted motor control training on chronic spinal pain: A randomized clinical trial. JAMA Neurology 2018;75:808-17.
27. Nijs J, Torres-Cueco R, Van Wilgen P, Lluch Girbés E, Struyf F, Roussel N, *et al*. Applying modern pain neuroscience in clinical practice: Criteria for the classification of central sensitization pain. Pain Physician 2014;17:447-57.
28. Wälti P, Kool J, Luomajoki H. Short-term effect on pain and function of neurophysiological education and sensorimotor retraining compared to usual physiotherapy in patients with chronic or recurrent non-specific low back pain, a pilot randomized controlled trial. BMC Musculoskeletal Disorders 2015;16:1-1.
29. Nijs J, Clark J, Malfliet A, Ickmans K, Voogt L, Don S, *et al*. In the spine or in the brain? Recent advances in pain neuroscience applied in the intervention for low back pain. Clin Exp Rheumatol 2017;107:108-15.
30. Ryan CG, Gray HG, Newton M, Granat MH. Pain biology education and exercise classes compared to pain biology education alone for individuals with chronic low back pain: A pilot randomised controlled trial. Man Ther 2010;15:382-7.
31. Moseley L. Combined physiotherapy and education is efficacious for chronic low back pain. Aust J Physiother 2002;48:297-302.
32. Bülow K, Lindberg K, Vaegter HB, Juhl CB. Effectiveness of pain neurophysiology education on musculoskeletal pain: A systematic review and meta-analysis. Pain Medicine 2021;22:891-904
33. Rufa A, Beissner K, Dolphin M. The use of pain neuroscience education in older adults with chronic back and/or lower extremity pain. Physiotherapy Theory and Practice 2019;35:603-13.
34. van Ittersum MW, van Wilgen CP, van der Schans CP, Lambrecht L, Groothoff JW, Nijs J. Written pain neuroscience education in fibromyalgia: A multicenter randomized controlled trial. Pain Practice 2014;14:689-700.
35. Robinson V, King R, Ryan CG, Martin DJ. A qualitative exploration of people's experiences of pain neurophysiological education for chronic pain: The importance of relevance for the individual. Manual Therapy 2016;22:56-6.

Appendix

Appendix A: Pain neuroscience education protocol for patients with osteoarthritis

- Introduction
- Structural diagnosis
  - Knee joint
  - Meniscus
  - Ligaments
  - Muscles.
- Biomedical diagnosis
  - Arthritis.
- Explaining therapy so far
  - Mechanism of physiotherapy treatment
  - Mechanism of medical treatment.
- Explaining pain biology
  - What is pain all about?
  - How it is processed and what can change it?
  - Sensitive alarm system.
- Explaining of what to expect from here
- Introduction
  - Firstly I would like to thank you for being the part of our study
  - I am a post graduate physiotherapy student in a institute of physiotherapy
  - We are doing this project because we have been learning so much about knee pain in the last few years that it is really important to focus on how we treat knee pain and what we can do to make it better
  - I want you to know about everything that affects pain. And will try my best to make you understand about pain
  - What I have found recently with my patients is that it can be really helpful to understand the biology of pain, particularly in knee pain because it can give some explanation for why it is so painful, when often a specific cause cannot be identified. I have also found that the more people know about their pain, and why they need to do certai1n exercises. This has also been shown in recent scientific studies. More knowledge about pain tends to help with these problems[1]
  - I'm going to ask you a lot of questions and provide explanation to your doubt, but at the end of this, I really hope that you have a clear understanding of what is going on with your knees, and help to plan your recovery
  - I hope you will also have a clear understanding about what to expect from here.
  - The aim of this is to give you a level of knowledge and understanding that you need to make the fastest recovery possible
  - My job is to make you understand pain, so let me know if you are unable to understand
  - The best evidence we've got, is that the things that determine recovery are the way you make sense of your pain, and not the things that are in your knee. Even now, I can tell that you are really worried about this, and feel that this is never going to get better. One of the biggest challenges for me is to explain you that this is not the case.
- Mechanism of injury
  - It's possible that you haven't damaged any tissue; but because there are so many alarm systems, the brain is always on the lookout to find if anything is wrong in the body! It hurts so badly that it could be any sort of problem. It is like few things which are not operating well in your body and the brain is just letting you know about it
  - The system is overly protective, and you're definitely on the verge of an injury. This is when the physiotherapist plays an important role; all you have to do now is make sure you return to function gradually.
- Talking about your worries
  - Can you tell what concerns you the most about this knee pain?

    - What thoughts cross you mind regarding the treatment of your knee in terms of medicine or therapy?
    - All these things are important for me to know because it affects your brain evaluation of danger.
    - For you'll it is really very important to remove the emotion and fear about the knee pain and rather talk about the systems that control these things. It's all about your brain's evaluation of danger and your immune system, endocrine system; sympathetic nervous system can modify that.When you worry, this will change your pain because you are worried about damage occurring in your knee
    - Are there any other worries that you have which we haven't covered?
    - My job is to teach you about pain, and I hope that by the end of my session, you will have a clear understanding of knee pain, what to expect from here and worry less about it.
- Explaining the diagnosis
- Knee joint
    - Image (complex knee joint lateral view)
    - This is a knee joint, we will not go into the complex design and working of the knee joint
    - But I will try to explain you the basic parts of your knee joint
    - There are two main bones in the knee joint and a small cap shaped bone in front of these two bones
    - The major part of it is the body weight transfers via these two bones.
- Meniscus
    - Image (meniscus anterior view in three-dimension)
    - This blue portion which you can see is called meniscus, which is basically a soft bed between the two bones
    - The main function of this structure is shock absorption, increase congruency, provide equal weight distribution, reduce friction and also participate in knee locking mechanism
    - In osteoarthritis there is reduced nutrition to this structure which further results in degeneration and which is the primary cause of joint space reduction in the joint.
- Ligaments
    - Image (illustrating all the ligament around the knee joint)
    - There are certain structures around the knee which provide support from all direction to the knee joint both when the knee is static as well as when it is moving
    - These are the following ligaments which supports the knee joint.
- Muscles
    - Muscles are prevalent to get injured but you need not to worry about it because they have an awesome blood supply and they heal really well
    - The other good thing about muscles is you can train them, and they are really adaptable
    - Since the muscles around your knee joint are weak it fails to provide adequate support to the knee and which in turn causes degeneration of the joint, but this can be controlled by exercises, stretches, Pilates
    - We are going to talk more about the protectiveness of the system and how we change this in other ways.
- Explaining biomedical diagnosis
- Osteoarthritis
    - "So your pain doesn't correspond to the onset of the alterations there, which makes sense because the danger receptors in the knee joint respond to fast changes rather than gradual changes," says the expert
    - I'll give you an example: if you place a 42-degree sensor on your finger, you can tell how hot it is because it does not trigger danger receptors, you can tolerate it for an hour or more, but you might acquire a burn of the third degree but if you place a 60-degree object there, the temperature changes so quickly that it becomes unusable
    - You remove it away so soon that it doesn't burn your skin – The protecting function is in effect!"
    - That is why cancer is so harmful. Because cancer cells do not grow rapidly, but rather gradually and silently, they have a detrimental effect on the body - this is dependent on the stimuli. The danger receptors will be activated if you make a quick adjustment
    - If the changes are relatively slow, the brain is likely to decide that no substantial threat exists
    - If there is no pain, the changes in the tissue are not seen as a threat by the brain

- People usually become aware of their anguish at some point. However, the true degeneration process did not begin at that time, but rather a long time previously
- X-ray findings may not always correspond to pain. Indeed, the x-ray changes would have seemed that way for a long time, and you haven't had a major issue until now
- Most people with deteriorated joints are completely unaware of it.

- Knee arthroscopy
  - Here is another example
  - There was a study in which Degenerative knees underwent an actual surgery or Placebo. The Surgeon went in and fixed it up, or went in and did nothing. And the results were the same. Half of the people that received the Placebo surgery couldn't believe they were in the control group because the results were so good
  - (However, youneedtobeverycarefulnottoimplythe"it'snotreal"implication)
  - Even when there is severe degeneration, we do the same things
  - Motion is lotion.

- Therapy so far

- Physiotherapy treatment
  - Physiotherapy treatment includes Patient education, manual therapy,[2] strengthening exercise, stretching and much more
  - It is really important to understand how exercising will help you in reducing the pain
  - Firstly in majority of cases of osteoarthritis there is wear and tear of the joint and cartilage of the knee
  - Now this can happen due various reasons which might be overweight, sedentary lifestyle, reduce strength and flexibility of the muscles around the knee joint etc
  - Since the strength of the muscles around the knee joint is usually found reduced, it is the major contributing factor for reduction of joint space which further worsen the condition
  - So working on the imbalance of muscle will definitely help you'll to slow the progression of the arthritis
  - Movement improves joint, soft tissue, circulatory, and respiratory system health
  - Educated movement is brain nourishing because it creates and re-establishes fine functional sensory and motor representations in the brain, using pathways which have been suppressed by fear and ignorance in the respiratory systems.

- Medical treatment
  - Tablets: They are really helpful to look after some of the chemical inflammation, it helps you to move
  - Injections: You hear stories of people who have had amazing success, but it doesn't always work. The thing is that you anaesthetize the danger messenger nerves as well as sensory nerves, so there is no way of knowing if it was danger messages or just normal sensory messages coming from that area
  - Surgery: Surgery should always be the very last option. The success rates of surgery for osteoarthritis are quite high. But again the implants which have different shelf life which might cause loosing of the implants or any other complication. It is usually suggested to go for a surgery in high grade osteoarthritis and for geriatric population.

- Pain biology

- What is pain?
  - Pain is an ordinary defensive reaction to something the mind has surveyed as harmful
  - Basically your brain is designed to get you out of trouble which is done by change of behavior
  - It includes all of your body systems and each of the reactions that happen are focused on healing and protection
  - These reactions then stop you from doing your activities of daily living. Which is fantastic if the pain is accurate? The common mindset of majority of you'll is that when in starts to pain we tend to overprotect the knee? Which is really good thing in cases where you really should protect it. But these chronic cases if we don't move enough then the problem will become worse
  - It's a framework that has been idealized all through the human evolution
  - There are many misconceptions, false impressions, and pointless feelings of dread with respect to pain
  - We've observed that seeing how and why we experience pain can be truly valuable for something like knee pain, because it can give some clarification why it is a particularly painful and disabling thing, regardless of whether there has been almost no tissue harm.

- Pain is protective
  - Pain safeguards you; it makes you aware of the risk, before you are harmed
  - But in some cases the pain system can act strangely and even fail
  - A fascinating fact about pain is that the level of pain you experience doesn't reflect how much harm that has occurred to you
  - At times we can have significant damage and no pain, and on different occasions, we can have minimal damage and a tremendous level of pain. Pain is most certainly not an accurate damage meter
  - So we know from the science of pain that it's anything but an indicator of damage, it is to a greater degree a defensive mechanism
  - Regardless of whether there is no tissue damage by any means if the mind has assessed a circumstance as compromising you can feel pain. If the brain threatens more the pain becomes worse.
- Pain is not a measure of tissue damage
  - Mostly, pain is experienced when your body caution system makes the cerebrum aware of genuine or potential tissue damage. However, this is just one piece of a bigger issue
  - Nociception isn't enough for pain
  - Assuming your brain has concluded that the circumstance isn't risky or compromising, then, at that point, the pain won't be experienced
  - If your brain feels that encountering pain is not ideal for surviving (envision an injured trooper hiding away from the enemy) you may not encounter pain at the hour of an extremely dangerous situation
  - Many changes in tissues are only ordinary pieces of being alive and they usually don't hurt
  - You can likewise have pain with no necessary information coming from the tissues
  - Stories: phantom limb etc
  - Researchers did a truly hidden test on volunteers who put their head inside a Placebo trigger and were informed that a current would be gone through their minds. Pain aroused by the increased power of stimulation even though no stimulation was given. That showed us that there is something else to encountering pain besides tissue damage
  - Pain is subject to complex neural handling and variation rather than being a powerful witness of knee pathology
  - Pain is dependent on complex neural processing and adaptation rather than being arousing former of spinal pathology.
- Pain tries to get us out of danger
  - However upsetting as it seems to be, pain works as an exceptionally helpful alarming system. It makes us change our conduct to get us out of risk. So disregarding pain is not a good idea. Where it gets precarious is in circumstances like knee pain, where individuals can regularly be confused with regards to what is the best way especially assuming our body is letting us know a certain feeling, similar to resting, and our physio is advising us to get moving
  - Pains from bad postures and injuries are basic "regular" pains that can be commonly connected with changes in tissues. The cerebrum presumes that tissues are in danger and you need to do something
  - Indeed, at the present, those tissues get special attention in terms of protection, than ever
  - Check whether what you are treating is protected by how lively the action you are doing is, instead of how much pain you are feeling. The mind is likely misjudging things
  - We have great proof that lets us know that remaining dynamic is vital for recovery from knee pain
  - We know scientifically why this can be painful in any case yet not damaging
  - Assuming you work with the physio step by step to get proactive in regular life, your tissues will be exceptionally protected, and you additionally promise your mind that it is great to move.
- Visual metaphors
  - Vision resembles the same
  - What we see isn't just an impression of light onto the retina
  - That sign goes through exceptionally intricate, split second handling to give us a picture that is naturally valuable
  - Pain is this way, it's a cognizant encounter in light of intricate neural handling, not just signals coming from the body

    - Pain, similar to vision, is a cognizant encounter that depends on numerous complicated cycles, in addition to the sensory information coming from your body.
- Thirst
    - Thirst is not an certified proof of dehydration
    - Like pain, thirst is something which changes our conduct
    - Nevertheless on several occasions we can be get dehydrated and still not be thirsty, in light of the fact that the mind has concluded there is no need
    - Pain performs in the same manner - it's nothing but a decent proportion of what is happening in the tissues since it is the result of numerous complicated cycles in the sensory system.
- The Pain Neurotag
    - There are more than one pain centers - there are stores of regions that pain
    - The brain acts as a "meaning attributor" to the incoming signals
    - There are many things which will affect the brains perception of pain which are
    - For example: Worries, Knowledge, Family, Culture, What the physio said, Scan results
    - This multitude of things will change the significance of that approaching danger information. When the mind considers this, it will conclude whether or not what is happening down there is truly dangerous
    - If the pain assessed as not really that dangerous than you will not experience any pain
    - If the pain assessed is to be very dangerous that the intensity would be 4 times of what it actual should be
    - This occurs in a brief moment, and it's outside of your control.
- Sensitive alarm system
    - Imagine you are walking alone and stepped on a nail would you feel it??
    - Of course you would feel it!
    - But how will you know?
    - Image (Metaphorical alarm system depiction of central sensitization after a painful experience)
    - Our body has a living body alarm system
    - Our Body consists of many network of nerves, at all times a little bit of electricity travels along the course
    - These nerve along from periphery to the brain and vice versa
    - It is supposed to take the sensory information to the brain
    - Okay, now tell me what will happen if the threat (nail) is removed?
    - Figure of a sensitivity of a pin prick
    - It is quite simple, once the threat is removed, the tissue will heal and the danger signal which was ramped up will come back to normal
    - Now similarly when there is lots of room for activities when there is no pain
    - And when the pain commences there is a very little room for activities which is usually caused due the hypersensitivity of the nerve
    - Image (depicting factors which contributes to lower the pain threshold)
    - So to lower this hypersensitivity of nerves, having proper understanding about the pain is really very important
    - Doing regular exercise as per prescribed by your physio will help to slow the chronicity of your knee and change the perception about pain.
- The drug cabinet in your brain
    - You will be surprised to know that how our brain is so well organized in every way.
    - As our doctors prescribe pain medications to relive our pain, similarly our brain also have a this function to release a pain relieving compound which is called opiates
    - Opiates such as endorphins, dynorphine, enkephalines etc
    - So in chronic cases, where the pain is since a very long time, these compounds dry up
    - Our brain does it purposefully to allow more information from the tissue about the danger potential
    - Turning on the faucet of pain medicine in your brain helps block incoming danger signals
    - How do we do it??
    - Exercise!! atleast of 15–20 min exercise within the target heart rate.
- What to expect from here.
    - The total number of episodes will definitely decrease, perception of pain will change and you will be stronger and fitter

- I can tell you're worried about it and practically certain it won't get any better
- Explaining to you why that doesn't have to be the case is one of my major challenges
- The system's nature is such that if you move slowly and consistently, the system will not allow you to harm anything
- However, if you progress too quickly, you may experience a flare-up
- If you sprained your ankle, it might feel a little better on day 3, but you wouldn't run on it just yet, would you?
- So you don't do that with knee either
- You'd see if you could take a few small steps, which could be quite painful, and then go back and try again tomorrow.

References

1. Louw A, Zimney K, O'Hotto C, Hilton S. The clinical application of teaching people about pain. Physiotherapy theory and practice. 2016;32:385-95.
2. Louw A, Nijs J, Puentedura EJ. A clinical perspective on a pain neuroscience education approach to manual therapy. Journal of Manual & Manipulative Therapy 2017;25:160-8.