



Review Article

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Proprioceptive neuromuscular facilitation approach for knee osteoarthritis conditions: A narrative review

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Abstract

Background: Knee pain is one of the most prevalent causes of musculoskeletal disorders worldwide. One of the most common causes of knee pain is osteoarthritis, especially in the elderly population. In physiotherapy management, several interventions are recommended as initial treatment for knee osteoarthritis conditions. One that has not so widely recommended and has good results in musculoskeletal cases is Proprioceptive Neuromuscular Facilitation. **Purpose:** This study aims to explore the application of PNF to the condition of knee osteoarthritis, which has been widely available in scientific articles in recent years. **Methods:** The method used in this study was narrative review which has the aim to summarize and analyze the PNF approach in osteoarthritis intervention. **Result:** After an extensive article search, 548 articles were found in the electronic database used. Then screening related to the title and abstract in accordance with the inclusion criteria and obtained 33 articles. After that, screening was conducted on the duplicated articles in the database, so that only 13 articles were not duplicates. Then, the accessibility of the article and the type of research were excluded, resulting in only 11 articles that will be included in the analysis of this study. **Conclusion:** Based on the data from 11 studies that have been discussed, it can be concluded that the treatment of joint knee osteoarthritis using the PNF concept dalam gave significant results in reducing pain, increasing the range of joint motion, increasing muscle strength and functional activities.

Keywords: Knee, Osteoarthritis, Proprioceptive Neuromuscular Facilitation, Physiotherapy.

INTRODUCTION

Knee pain is one of the most prevalent causes of musculoskeletal disorders worldwide. According to data from the Global Burden of Disease, the prevalence of knee pain increases with age, with the highest prevalence in individuals over the age of 50 [1]. Knee pain is a common complaint that can affect individuals of all age groups. The causes of knee pain are quite multifarious, ranging from acute injuries such as torn ligaments or damaged cartilage, to medical conditions such as arthritis, gout, and infections [2]. In addition, knee pain can significantly affected a person's quality of life, limiting daily activities and reducing mobility [3]. One of the most common causes of knee pain is osteoarthritis, especially in the elderly population [4]. This condition is caused by degeneration of the cartilage that covers the ends of the bones in the joint. As people get older, the cartilage becomes thinner and breaks down, causing friction between the bones which results in pain and swelling [5]. In addition, other risk factors such as obesity, previous injuries, and excessive physical activity can also increase one's chances of experiencing knee pain [6]. The management of knee pain varies depending on the cause and severity of the pain. Non-surgical methods such as physiotherapy interventions, the use of nonsteroidal anti-inflammatory drugs (NSAIDs) and lifestyle changes are often the first step in treatment [7]. However, in severe cases, surgical interventions such as arthroscopy or joint replacement may be required to reduce symptoms and improve knee function [1].

In physiotherapy management, several interventions are recommended as initial treatment for knee osteoarthritis conditions such as education, strengthening exercises, aerobic exercise, range of motion exercises and others One that has not so widely recommended and has good results in musculoskeletal cases is Proprioceptive Neuromuscular Facilitation [8]. Proprioceptive Neuromuscular Facilitation (PNF) is an intervention concept in physiotherapy based on the philosophy that all humans including people with disabilities have unutilized potential [9]. In its practice, PNF has a philosophy, concepts and techniques and procedures that can be used to reduce disorders arising from knee osteoarthritis such as pain, limitation of movement and impaired functional activities [10]. In this study, the authors investigate the application of PNF to the condition of knee osteoarthritis which in recent years is quite widely available in scientific articles. The results of the search will be reviewed in more detail to explore the effect of PNF on knee OA

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conditions with various outcome measures.

METHODOLOGY

The method used in this study was narrative review which has the aim to summarize and analyze the PNF approach in osteoarthritis intervention. The narrative review method was chosen in order to provide a more comprehensive overview of the topic of PNF in the management of knee osteoarthritis conditions and the limited literature available for systematic review [11,12]. The literature search strategy used electronic databases such as PubMed, Pedro and Google Scholar with a time limit from 2020 to August 2024. The combination keywords used in the literature search were “Proprioceptive Neuromuscular Facilitation,” “PNF,” “osteoarthritis,” “knee,” and “Knee Osteoarthritis.” The boolean operators AND and OR were applied to expand the search. In addition, a manual search was conducted by browsing the references of relevant articles to identify additional significant studies [13]. Inclusion criteria were not strictly applied, only emphasis was made such as accessible research and focusing on PNF interventions, experimental research or randomized control trials, studies reporting the effects of PNF on knee osteoarthritis conditions, English language articles and not systematic review research. While the exclusion criteria are studies in the form of systematic review meta-analysis, articles that are not in English and

cannot be accessed [11,14]. The results of the article search are presented in the tabel format that provides information in the form of article author, study design, Knee OA classification, PNF intervention details, comparison interventions, outcome measurements and results with conclusions. The data presented is then thoroughly identified with the aim of providing information about the effectiveness of PNF on osteoarthritis conditions. The discussion will also include the mechanisms behind the effects of PNF and the limitations of the literature.

RESULTS AND DISCUSSION

After an extensive article search, 548 articles were found in the electronic database used. Then screening related to the title and abstract in accordance with the inclusion criteria and obtained 33 articles. After that, screening was conducted on the duplicated articles in the database, so that only 13 articles were not duplicates. Then, the accessibility of the article and the type of research were excluded, resulting in only 11 articles that will be included in the analysis of this study (Figure 1). A description and analysis of the 11 research articles on PNF for knee OA is presented in the table 1.

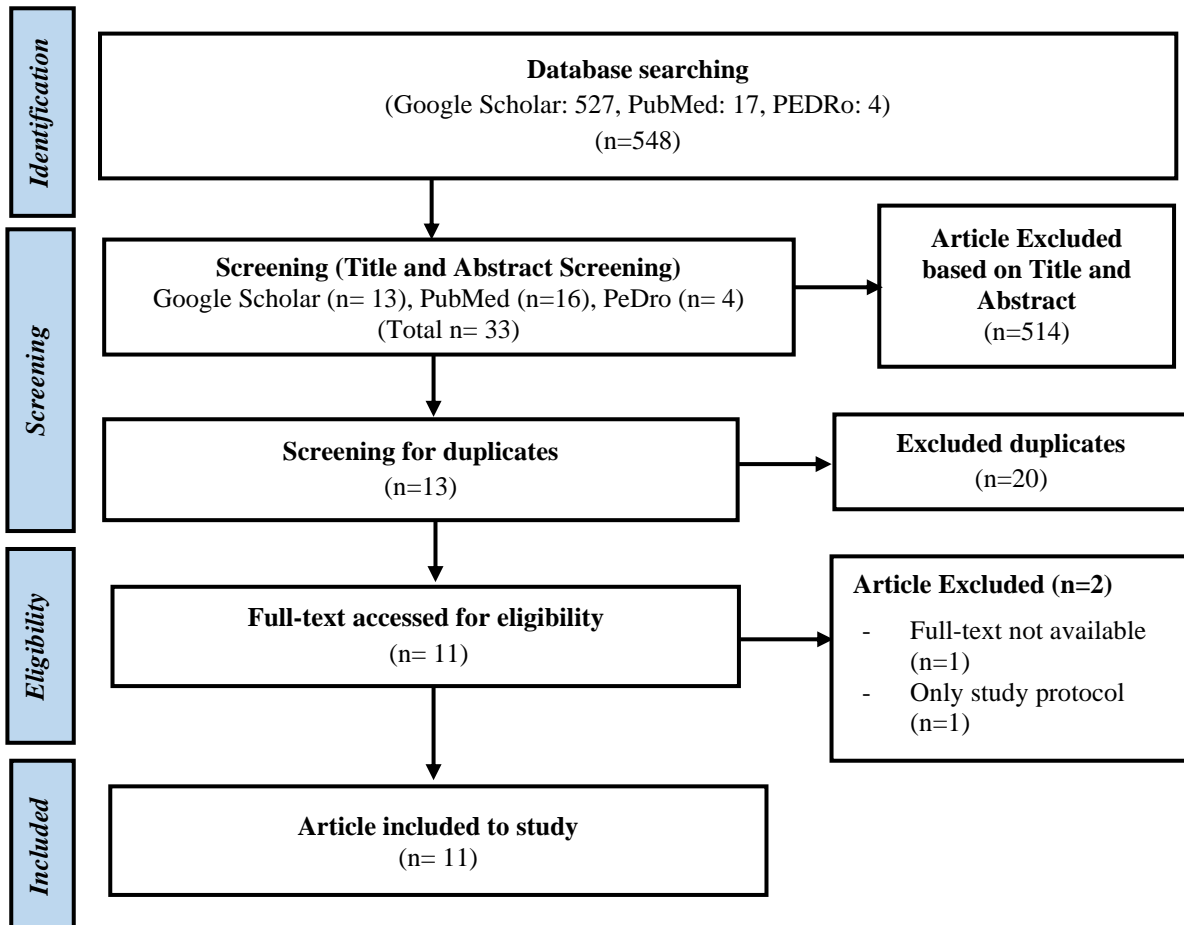


Figure 1: Study Flowchart

Table 1: List of articles

| Author (Year) | Study Design | Knee OA Classification | Duration and PNF Approach | Comparison | Outcome measure | Result and Conclusion |
|------------------------|---|--|--|---|--|---|
| Masekar et al. (2020) | Quasi-Experimental | Knee OA grade 2 or 3 Kellgren – Lawrence (KL) classification | Hold-Relax (8 sec hold, 10 sec relaxation) <ul style="list-style-type: none"> - Two sets of five repetition - Combined with moist hot pack and Interferential therapy | Muscle Energy Techniques (MET) <ul style="list-style-type: none"> - Post isometric relaxation - Reciprocal Inhibition - Both with 2 sets of 5 repetition Combined with moist hot pack and Interferential therapy | <ul style="list-style-type: none"> - Numeric Pain Rating scale (NPRS) - Active Knee Extension Test (AKET) - Western Ontario and McMaster Universities Arthritis Index (WOMAC) | PNF group (Hold-relax) showed more significantly better improvement in NPRS, AKET and WOMAC compared to MET group |
| Song et al. (2020) | Quasi-Experimental | Elderly with knee OA grade 1 to 3 KL Classification | PNF Intervention three times a week for 12 weeks; <ol style="list-style-type: none"> 1. PNF Pattern (lower extremity) <ul style="list-style-type: none"> - Flexion-abduction-internal rotation - Extension-adduction-external rotation - Flexion-adduction-external rotation - Extension-abduction-internal rotation 2. PNF Techniques (5-8 times for 3 sets) <ul style="list-style-type: none"> - Contract-relax - Hold-Relax - Dynamic Reversal - Repeated Stretch 3. Position: Supine lying without side-bending or rotation | No intervention (Watching television or read magazine) | <ul style="list-style-type: none"> - WOMAC - Passive Knee Flexion and Extension Range of motion (ROM) - Stair descent testing protocol | PNF intervention reduce pain, improve passive Knee ROM and increase Hip adduction moment (HAM) during stair descent |
| Nathani & Tank, (2020) | Quasi-Experimental | Knee OA Grade 2 or 3 KL Classification | PNF Techniques for three times a week for 6 weeks. <ol style="list-style-type: none"> 1. Hold-Relax for Hip Adductors (10 sec hold, 30 sec rest, 30 stretching) 2 sets 2. Hold-Relax for Hamstring (10 sec hold, 30 sec rest, 30 stretching) 2 sets | Conventional therapy once a week for 6 weeks. <ol style="list-style-type: none"> 1. Shortwave diathermy (10 minutes) 2. Exercise (10 repetitions each exercise) <ul style="list-style-type: none"> - Isometric Exercise for quadriceps - High Sitting knee extension - Straight leg raise - Active Hip Abduction | <ul style="list-style-type: none"> - Absolute Angle Meter (ROM and Proprioception) - Modified WOMAC | PNF techniques shows significant in improving proprioception with physical function in patients with knee OA than conventional therapy |
| Gökşen et al. (2021) | Prospective randomized controlled study | Knee OA grade 1 to 2 KL Classification | Two PNF group with three days a week for 6 weeks. <ol style="list-style-type: none"> 1. Group 1 (Repeated Stretch) <ul style="list-style-type: none"> - Hot pack and Ultrasound - Hold-Relax - Repeated Stretch | Conventional Physiotherapy for three days a week for 6 weeks <ul style="list-style-type: none"> - Hot pack and Ultrasound - Isometric and isotonic | <ul style="list-style-type: none"> - Muscle Strength and muscle endurance (Biodex System Pro3) - Proprioception with active position (With biodex system) | <ul style="list-style-type: none"> - PNF techniques in combined isotonic group is more advantageous then other group for knee extensor muscle strength and proprioception. |

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|------------------------------|-----------------------------|---|--|--|---|--|
| | | | <p>2. Group 2 (Combined isotonic)</p> <ul style="list-style-type: none"> - Hot pack and ultrasound - Hold-Relax - Combined Isotonic | <p>exercise for hip and knee muscles</p> <ul style="list-style-type: none"> - Mini squat and lunges | | <ul style="list-style-type: none"> - Both Combined isotonic group and Repeated stretch group more significant in term of muscle endurance compare to conventional physiotherapy group. |
| Zaidi et al. (2023) | Randomized control trial | Knee OA grade 1 to 2 KL Classification | <p>PNF technique with three times a week for four for week.</p> <ul style="list-style-type: none"> - Contract-Relax (5 sec contractions, relaxation and 5 sec stretching) - 2 sets, 2 repetition | <p>1. Lower extremity static Stretching with three times a week for four for week.</p> <p>2. Control group: no intervention</p> | <ul style="list-style-type: none"> - Maximal Voluntary Isometric Contraction for Biceps Femoris - Active Knee Joint ROM Measurement - Chair Sit-and-Reach Test (CART) | <ul style="list-style-type: none"> - PNF group showed better immediate effect on active ROM and Hamstring muscle flexibility and also for long term effect on hamstring muscle activity and flexibility. - Static stretching is better only for long-term effects of flexibility. |
| Gao et al. (2023) | Randomized controlled trial | Older adult with knee OA Grade 2 or 3 KL Classification | <p>PNF approach for three sessions per week for 8 weeks.</p> <p>1. PNF Pattern (lower extremity)</p> <ul style="list-style-type: none"> - Flexion-Abduction-Internal - Extension-adduction-external - Flexion-adduction-external, - Extension-abduction-internal rotations <p>2. PNF techniques</p> <ul style="list-style-type: none"> - Contract-relax - Hold-relax - Reversal of antagonist - Repeated Stretch | <p>Health lecture series for 8 weeks, 3 one-hour sessions per week.</p> <ul style="list-style-type: none"> - Knowledge about Knee OA - Awareness of chronic diseases - psychological health education - Nutritional meals, scientific - Exercise - Exchange of experience. | <ul style="list-style-type: none"> - Pain with Visual Analogue Scale (VAS) - Knee abduction moment (KAM) - Gait Pattern (Foot Clearance, Step length, crossing velocity) | <ul style="list-style-type: none"> - PNF was effective in reducing knee pain - PNF showed significant between-group differences in KAM - PNF showed significant in crossing velocity. - No significant difference between PNF and Control group in step length and foot clearance. |
| Kalunke, A (2023) | Quasi-Experimental | Knee OA Grade 2 or 3 KL Classification | <p>Rhythmical Stabilization</p> <ul style="list-style-type: none"> - 2 sets of 5 Repetition - Three times a week for 6 weeks - Along with moist hot pack (10 minutes) and Interferential therapy (15 minutes) | <p>Conventional physiotherapy</p> <ul style="list-style-type: none"> - Moist hot pack for 15 minutes - Isometric quadriceps exercise - High sitting knee extension - Straight Leg Raise - One set 10 Repetition for exercise - Five times a week for six weeks | <ul style="list-style-type: none"> - Functional outcome with WOMAC - Pain with VAS | <ul style="list-style-type: none"> - Both group were beneficial to reducing pain and improving functional mobility - PNF group showed more superior in pain reduction and improving functional mobility then conventional physiotherapy group |
| Komalasari & Gazella, (2023) | Quasi-Experimental | Knee OA at least grade 2 KL Classification | <p>PNF techniques two times for four weeks</p> <ul style="list-style-type: none"> - Targeting quadriceps and hamstring muscles - Hold-Relax - Contract-Relax - Contract-relax agonist contract (CRAC) - Two sets for four | No comparison | <ul style="list-style-type: none"> - Pain with Numeric Rating Scale - Timed up and go test (TUG) - Functional Reach Test (FRT) | <p>PNF showed significant positive effect in reducing pain and improving postural balance.</p> |

| | | | | | | |
|----------------------|-----------------------------|--|---|---|---|--|
| | | | repetition | | | |
| Anjum et al. (2023) | Randomized controlled trial | Knee OA grade 1 to 2 KL Classification | <p>Hold-relax</p> <ul style="list-style-type: none"> - Three times a week for six weeks - Targeting hamstring muscles - One set for three repetition - Combined with hot pack for hamstring muscles and knee joints for 15 minutes. | <p>Instrument Assisted Soft Tissue mobilization technique using contoured stainless-steel</p> <ul style="list-style-type: none"> - Three times a week for six weeks - 30 gentle strokes from origin to insertion at 45-degree angle - Combined with hot pack for hamstring muscles and knee joints for 15 minutes | <ul style="list-style-type: none"> - Pain with VAS - Hamstring flexibility with Active Knee Extension test (AKET) - Health status with WOMAC | <ul style="list-style-type: none"> - Both group showed significant improvement in pain, hamstring flexibility and health status - IASTM technique group showed more significant improvement in hamstring flexibility, pain and health status compared to PNF group. |
| Nafees et al. (2023) | Randomized controlled trial | American College of Rheumatology clinical and radiological classification criteria for Knee OA | <p>Hold-relax technique</p> <ul style="list-style-type: none"> - Three times a week for four weeks - Targeting hamstring muscles - One set for three repetition <p>Combined treatment</p> <ul style="list-style-type: none"> - Cryotherapy: cold pack on anterior knee joint for 10 minutes - Isometric Quadriceps Strengthening Exercises - Isometric Hip Adductor Strengthening Exercises | <p>Dynamic soft tissue mobilization technique</p> <ul style="list-style-type: none"> - Three session per week for four weeks - Targeting hamstring muscles <p>Combined treatment</p> <ul style="list-style-type: none"> - Cryotherapy: cold pack on anterior knee joint for 10 minutes - Isometric Quadriceps Strengthening Exercises - Isometric Hip Adductor Strengthening Exercises | <ul style="list-style-type: none"> - VAS - Active Knee Extension test (AKET) - Functional outcome: Knee injury and Osteoarthritis Outcome Score (KOOS) | <ul style="list-style-type: none"> - Both treatment is significantly and equally effective in knee OA treatment - No significant different between group in reduction of hamstring tightness, decreasing pain intensity, and functional mobility improvement in knee osteoarthritis. |
| Salehi et al. (2024) | Quasi-Experimental | Osteoarthritis in one or both knees confirmed by radiographic evidence | <p>Hold-relax</p> <ul style="list-style-type: none"> - Targeting quadriceps and hamstring muscles - One set for three repetition - Two times a week for 8 weeks | No intervention | Manual Muscle Strength Test (quadriceps and hamstring) | PNF showed significant in improving muscle strength. |

Typically, research into PNF approaches for knee OA uses the Kellgren-Lawrence (KL) classification. This classification provides a clear classification of the patient's condition that allows for conservative treatment [26]. However, there are also studies that do not use KL classification in determining the condition of OA knee [24,25]. In 2020, there were three published studies on PNF for knee OA conditions. All three studies used quasi-experimental research methods. In general, the results of applying the PNF approach to OA conditions provide a better result compared to the comparison intervention. In particular, the study by Masekar et al., did not use the entire PNF approach such as the pattern and length of intervention provided and only provided related techniques, namely hold-relax [15]. The comparison intervention is muscle energy techniques with PNF results that better in reducing pain and increasing functional abilities. Later, research by Song et al., provide precise details regarding dosage as well as techniques, patterns and positions in the application of PNF. The techniques used were quite varied, including contract-relax, hold-relax, dynamic reversal and repeated stretch. However, the comparison intervention was only a control group without any comparable intervention. The results of the study showed that PNF improved knee ROM as well as hip abduction movement when patients climbed stairs.

Furthermore, another study in 2020 was reported Nathani & Tank. In their study, the details given were only PNF techniques, namely only hold-relax along with the dosage [17]. The comparison intervention is quite commensurate with the provision of conventional interventions in the form of shortwave diathermy and general exercise. The results obtained in the study were that PNF provided more significant results in improving knee function (ROM) compared to conventional therapy interventions.

Furthermore, in 2021, as far as the search was obtained, only one study could be found. Research by Gökşen et al., was conducted using the prospective randomized controlled study method by comparing two PNF techniques, namely repeated stretch and combined isotonic and a control group in the form of conventional physiotherapy treatment [18]. The study described the dose of the intervention in both the intervention and control groups. This study was quite well conducted in terms of outcome measures that used muscle strength and muscle endurance as well as proprioception. In the results, it was stated that the combined isotonic group was better at improving knee extensor muscle strength compared to the other interventions. Furthermore, both groups that received PNF intervention had better results in muscle endurance of the knee compared to the conventional physiotherapy group.

In 2022 there were no research reports on the application of PNF to knee OA conditions. Furthermore, in 2023 there were six research articles that reported the results of the PNF approach to knee OA. Research by Zaidi et al., reported their research on PNF approach for knee OA condition [19]. With a randomized control trial research method, the study compared PNF contract-relax technique with two comparison groups such as lower extremity static stretching and a control group without any intervention. The examination was comprehensive using maximal voluntary isometric contraction, active knee ROM and Chair Sit-and-reach test (CART). This study reported that the PNF group provided better results in active knee ROM. However, the use of the PNF approach was incomplete and only used techniques.

Furthermore, research by Gao et al., with the RCT research method used a fairly complete PNF approach, namely patterns, positions and techniques [20]. The comparison intervention used was a health lecture related to knee OA that directed the study participants to stay healthy with OA. The examination was also quite comprehensive in terms of pain, knee abduction moment and gait pattern. The techniques used

were quite varied from contract-relax, hold-relax, reversal of antagonist and repeated stretch. The results of this study showed that PNF group was more effective in reducing pain and knee abduction moment. However, in terms of gait pattern, there was no difference between the PNF group and the control group. Followed by research by Kalunke, which used one technique, namely rhythmical stabilization compared to conventional physiotherapy treatment. The use of moist hot packs was also given to the intervention group and the comparison group. The results of the study stated that PNF was better in reducing pain and increasing functional mobility. Another study with a quasi-experimental method was conducted by Komalasari & Gazella, without comparative intervention [22]. PNF technique used was aimed at the quadriceps and hamstring muscles with hold-relax, contract-relax, contract-relax agonist contract techniques. The examination used consisted of pain, time up and go test and functional reach test. From the study it was reported that PNF gave positive results on the condition of knee OA based on the evaluation.

Further research provides different results by comparing PNF techniques, namely hold-relax with instrument assisted soft mobilization (IASTM) [23]. The evaluation included pain, hamstring flexibility and health status using WOMAC. From the results, it was found that the comparison group with IASTM intervention provided significant improvement in pain, muscle flexibility and health status compared to the PNF group.

Another study conducted in 2023 was reported by Nafees et al., For this study, PNF hold-relax intervention was used and combined with other interventions and compared with dynamic soft tissue mobilization [24]. Outcome measures that are used include pain using VAS, active knee extension and functional outcomes using KOOS. The results of the study showed no significant difference between the PNF and Dynamic soft tissue mobilization intervention groups. However, both groups had good results for each of the study participants.

A recent study in 2024 by Salehi et al. used only PNF approach with hold-relax technique and compared with a control group without intervention [25]. In this recent study, the outcome measure only used manual muscle strength tests for quadriceps and hamstring muscles. In the results obtained PNF provides an increase in muscle strength in both hamstring and quadriceps muscles.

From the research that has been collected, most studies use hold-relax and contract-relax techniques followed by variations of techniques such as combination of isotonic, reversal of antagonist, repeated stretch, and rhythmical stabilization. Theoretically, this is consistent with the purpose of these PNF techniques [27]. Primarily, the hold-relax technique is used for pain reduction and increased joint range of motion [28]. The hold-relax technique is a facilitation technique that is carried out by providing appropriate resistance when performing isometric contractions, then followed by relaxation and then movement towards a new joint scope of motion, this technique aims to relax and stretch the muscles, increase the scope of joint motion and reduce pain [27]. Moreover, the technique that is often used is contract-relax. Contract relax is a facilitation technique that is conducted in a similar way to hold-relax but provides resistance during isotonic contraction [9]. This technique specifically aims for muscle relaxation and stretching, increased joint range of motion but without the presence of pain [27].

Theoretically, the PNF approach should not only use techniques, but also use or approach handling based on philosophy, basic principles and procedures [10]. In the research findings collected, there are only two studies that explain in detail the use of PNF in knee OA conditions [16,20]. The use of a complete PNF approach will provide more comprehensive treatment of the patient's condition with movement

disorders [8]. In addition, providing a comprehensive PNF approach will also affect the function of the impaired knee, as it will reinforce motor learning [10]. Thus, knee functions such as walking, sitting, standing and other functional abilities can be improved, not only pain reduction and increased joint range of motion [29-31].

Although the treatment management in previous studies did not use all components and elements contained in the PNF concept such as basic principles and complete procedures but only used techniques, the use of PNF in knee OA conditions will still have a beneficial effect. The use of the PNF approach in knee OA conditions will also provide another option in interventions in musculoskeletal conditions, so that PNF is considered not only for neuromuscular cases [8,10].

This study has some limitations such as the method used was not a systematic review meta-analysis, although there was a system used to screen the research articles obtained. In addition, in the search, some relevant studies could not be accessed and reported in this study. Furthermore, research with better methods can be conducted to add to the development of PNF application in musculoskeletal conditions, especially knee OA. Additionally, access to some research results also needs to be improved in order to present more comprehensive research search results.

CONCLUSION

The PNF concept has a philosophy, principles and procedures as well as handling techniques that can overcome various symptoms or problems that arise such as pain, limited scope of joint motion and impaired functional activities in the knee area which is a joint and is an area for proprioceptive stimulation. In musculoskeletal conditions, especially knee osteoarthritis with complaints or problems such as pain, limited range of motion of the joints and impaired functional activities, techniques that can be used as therapeutic measures along with the philosophy, principles and procedures of the PNF concept are such as hold relax, contract relax, rhythmical stabilization, reversal of antagonist and repeated stretch.

Based on the data from 11 studies that have been discussed, it can be concluded that the treatment of knee osteoarthritis using the PNF concept in a time range that varied between 4-12 weeks with an interval of 3 times a week, gave significant results in reducing pain, increasing the range of joint motion, increasing muscle strength and functional activities.

Recomendation

Physiotherapists can use the PNF approach in knee OA conditions as an intervention option in addition to the application of general conservative interventions. Physiotherapists are also expected to use a complete PNF approach in accordance to achieve comprehensive treatment of problematic patients.

Conflict of interest

The authors reports no conflicts of interest.

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