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TITLE: Proprioceptive Nueromuscular Facilitation (PNF)

BODY COPY:

Definition

Proprioceptive Nueromuscular Facilitation (PNF) is defined as a form of stretching and strengthening used in physical therapy and athletic training. The patient isometrically contracts the muscle to be stretched for various seconds, then relaxes that muscle as the therapist performs a gentle passive stretch. PNF is applied to help increase range of motion within a joint, help treat soft tissue disorders, and it is often used with other modalities. [1]

While PNF is often defined as a stretching technique, it has a wider context in its physiological aspect. Because of the use of contractions, PNF may help strengthen joints and encourage kinesthetic awareness in the body. Like many manual therapy modalities, PNF is performed differently from therapist to therapist. Variables include length of stretch hold, length and type of contraction, and the protocol of additional movements.

Aspects of PNF are easily taught to the therapist, but it does require clinical practice to perform it safely. Also, the condition of the patient's soft tissues must be considered. Joint laxity, muscle tightness and atrophy, allow for a greater chance of injury when performing PNF.

1. Agnew, Timothy, et al. Kinesiology for Manual Therapies. McGraw Hill, 2010.

History

Proprioceptive Nueromuscular Facilitation (PNF) was developed by Herman Kabat, MD, and Margaret Knott, PT, in the period between 1940 and early 1950s, as a protocol for helping neurological dysfunctions. [1] Kabat, known for physically working with his patients, began to wonder if there was a benefit beyond range of motion protocols. He studied the works of Sherrington, Gellhorn, Coghill, Gesell, Hellebrandt, et al., searching for answers. The provoking research, especially by Charles Sherrington, showed that a muscle response could be influenced by resistance, myotatic reflex, and other proprioceptive stimulus. Inspired by his studies, Dr. Kabat searched for clinicians whose treatment philosophy matched his own principles. [2,3]

PNF is a modality that germinated from its focus on specificity. When Knott began to work with Kabat in the 1940s, they began to place a focus on resistance, myotatic reflex arc (stretch reflex), and techniques of traction to better understand responses in muscle groups. [2] While the concepts of PNF are founded upon proven neurophysiological and kinesiological principles, clinical knowledge played an enormous role in its development. Kabat and Knott's mutual agreement was to help facilitate the patient's response to therapy by ingraining strengths, and not limitations.

1. Kabat H. Proprioceptive facilitation in therapeutic exercise. In: Licht E, ed. Therapeutic exercise. 2nd ed. New Haven: E Licht, 1961

2. Knott M, Voss B. Proprioceptive neuromuscular facilitation.

3. Voss DE. Proprioceptive neuromuscular facilitation. Am J Phys Ther 1967; 46.838-899.

Therapeutic Aim or Mechanism

The ultimate goal of using PNF in manual therapy is to facilitate joint stability and optimal neuromuscular functioning. This assists in a reduction of symptoms and decreases forces acting on the joint. Improving poor motor control helps functional movement by changing the inherent faulty mechanics of both agonist and antagonist muscle groups.[1,2]

Through afferent stimulation of the central nervous system, muscles are encouraged to contract and lengthen, essentially what they were designed to do. This form of re-education develops the ability of the muscle to fire, whether it's a prime mover or synergist. Since all muscles work together to cause a joint action, this functional movement creates a balance between muscle groups, and allows for improved movements. [3]

While stretching is a large component of PNF, its other therapeutic aim is strengthening. In PNF, this occurs in the body through movement patterns. These patterns are based on the theory that the body only knows of “patterned" or functional movement. Two pairs of diagonal movement exist. Patterns performed in flexion and extension is often referred to as D1 flexion, D1 extension, D2 flexion or D2 extension techniques for the upper or lower extremity. For soft tissue injuries, strengthening the affected joints using diagonal movement patterns allows the muscles to be strengthened every way they move a joint. [4,5]

1. Knott M, Voss B. Proprioceptive neuromuscular facilitation. 2nd ed. London, England: Balleire, Daintily

2. Guyner A]. Proprioceptive Neuromuscular Facilitation for Vertebral Joint Conditions. In: Grieve GP, ed. Modern manual therapy of the vertebral column. London: Churchill Livingstone, 1986.

3. Showman, JC. TheRational of Patterns and Techniques of Proprioceptive Neuromuscular Facilitation.Australian Journal of Physiotherapy 8: 115-120.

4. Kabat H. Proprioceptive facilitation in therapeutic exercise. In: Licht E, ed. Therapeutic exercise. 2nded. New Haven: E Licht, 1961.

5. Knott M, Voss B. Proprioceptive neuromuscular facilitation. 2nd ed. London, England: Balleire, Daintily& Cogs, 1968

Indications for Treatment

Some studies indicate PNF is an effective modality that can be used on every age population. Klein et al. showed that using PNF techniques for older adults improved range of motion, isometric strength and selected physical function tasks. [1] Additional studies showed that PNF stretching is more effective than static stretching in improving hamstring flexibility in people 45 to 75 years of age. [2] Most studies, however, are limited to the comparison of only static-based stretching modalities.

Since PNF techniques involve specific movement and positioning, the effectiveness of its application depends largely on the therapist's skill and clinical experience. PNF can be used with other neuromuscular modalities, and is useful for treatment of chronic soft tissue injuries as well as for increasing flexibility. PNF covers a wide scope in all aspects of the rehabilitation process, including restricted range of motion, stroke, movement improvement, and strength. [3]

1. Klein, D., Stone, W., Phillips, W., Gangi, J., & Hartman, S. (2002). PNF training and physical function in assisted-living older adults. Journal of Aging and Physical Activity, 10(4), 476-488.

2. Ferber, R., Gravelle, D., & Osternig, L. (2002). Effect of proprioceptive neuromuscular facilitation stretch techniques on trained and untrained older adults. Journal of Aging and Physical Activity, 10(2), 132-142.

3. Feland, J., Myrer, J., & Merrill, R. (2001). Acute changes in hamstring flexibility: Proprioceptive neuromuscular facilitation versus static stretch in senior athletes. Physical Therapy in Sport, 2(4), 186-193.

Advantages and Benefits

PNF has evolved into practical tool for any manual therapist. While there are many different techniques involved with its application, its clinical focus on muscle reeducation remains the same. Compared to a static-type stretch protocol, where muscle fibers are lengthened by passive movements and long holds, PNF offers a more effective approach that includes both a contraction and lengthening of muscle tissue. PNF does require skill development to apply correctly with safe outcomes. Careful assessment of the patient is required, and patient-therapist feedback is important during a PNF treatment. In a sports medicine setting, PNF is and effective treatment for the athlete, and may be applied both on the playing field and in the clinic.

Practice Settings

PNF is used in physical therapy and sports medicine clinics, athletic departments, and hospitals. Athletic and personal trainers also use PNF in practice. It can be applied on a therapy table or on the athletic field. Since it is a therapist-assisted modality, it can be difficult to teach a self version to the patient or athlete. Some athletes use walls or other structures to assist in the isometric contraction and stretch, yet for most its complexity makes learning it very difficult. PNF is most effective when applied with assistance from a skilled therapist in a professional setting.

Assessments

As with other manual therapy modalities, comprehensive orthopedic and neurological assessment

protocols must be applied before using PNF. Specific injuries, chronic dysfunctions, and other neurological disorders must be identified to avoid injury. The therapist must be skilled in assessment, and understand the proper tests and the degree of injuries. Yet she also must interpret MRI and other radiological reports, as these may offer clues to the dysfunction. PNF may or may not be indicated for treatment depending on the assessment outcome, or it may need to be varied or used with other modalities.

Equipment/Materials

No equipment is required for application of PNF, but a therapy table is helpful for the body positioning.

Guidelines and Protocols

PNF has many variations, (these will be discussed later), yet the essential components remain the same. Since PNF stretching is based on spiral-diagonal movements that Kabat and Knott formulated while developing it, every PNF technique utilizes this theory of "mass movement" patterns. Muscles cause rotation and move joints in diagonals, and therefore muscles must contracted and stretch in this fashion. [1] PNF protocols were designed to facilitate muscular inhibition, which allow for a more effective stretch. To help achieve this, isometric and concentric muscle actions are completed immediately before the passive stretch help to attain autogenic inhibition, a relax reflex that occurs in the same muscle where the golgi tendon organ is located. The isometric contraction is most often referred to as 'hold' and the concentric muscle contraction 'contract'. Holds on these contractions vary from 6-10 seconds.

Other guidelines include:

- Allow 24-48 hours between PNF stretching routines.
- Avoid PNF immediately before competition
- For each muscle group complete 2-3 sets of an exercise.
- Each set should consist of one stretch held for up to 30 seconds after the contracting phase. Perform only one exercise per muscle group in a session.

1. McAtee, Robert. Facilitated Stretching 3rd ed. Human Kinetics Publishers, 2007.

Basic Techniques or Methods

The basic Hold-Relax protocol of PNF would only be applied after careful assessment. Joint limitations, injuries, and other health issues must be identified before proceeding. It is also important to understand the patient's goals, for example, injury prevention and increased flexibility in a particular group of muscles. For the hamstring muscle group, the therapist moves the patient's extended leg to a point of mild discomfort. This passive stretch is held for 6-10 seconds. The therapist then instructs the patient to isometrically contract the hamstrings by pushing the extended leg against the therapist's hand. The therapist applies force to prevent the hip from moving into extension. This is the 'hold' phase and lasts for approximately 6 seconds. The patient is then instructed to 'relax' the leg so that the therapist can apply another passive 10-30 second stretch.

Variations of Technique or Method

Including the most common Hold-Relax method mentioned earlier, there are two other PNF stretching variations, and even these are done differently from therapist to therapist. The goal once again is to facilitate autogenic inhibition activated in the hamstrings.

Contract-Relax

The therapist moves the patient's extended leg to a point of mild discomfort. This passive stretch is held for 6-10 seconds. The patient concentrically contracts the hamstrings by pushing the extended leg against the therapist's hand. The therapist applies enough force so that there is resistance as the patient extends the hip to the table in a full range of motion. This is the 'contract' phase. The patient is then 'relaxes' and the therapist completes a second passive stretch held for 10-30 seconds.

Hold-Relax with Opposing Muscle Contraction

The therapist moves the patient's extended leg to a point of mild discomfort. This passive stretch is held for 6-10 seconds. The patient isometrically contracts the hamstrings by pushing the extended leg against the therapist's hand. The therapist applies just enough force so that the leg remains static. This is the 'hold' phase and lasts for 6 seconds. The therapist completes a second passive stretch held for 10-30 seconds; however, the patient is instructed to flex the hip, pulling the leg in the same direction as it is being pushed. This initiates reciprocal inhibition allowing the final stretch to be greater.

Contraindications (disadvantages) (maximum 200 words)

Contraindications: Pain should not be produced during PNF movements. Patients with post surgery issues, artificial joints, and special populations should be screened carefully. Since PNF depends on muscle contraction and joint movement, patients who are unable to do so are not good candidates for this modality. Patients must be able to understand commands and be able to provide feedback during a PNF session. It is not recommended for patients under the age of 18.

Disadvantages: PNF, while easily taught, can be complicated to perform because of its many steps, and difficult to master. Because of its complexity it is not viable to teach as a self-help stretching modality.

Stanford Health, Body Copy:

Before Edits:

As for many food components, the intake of metal ions can be a double edged sword. The requirement for ingestion of trace metals such as Fe and Cu ions to maintain normal body functions such as the synthesis of metalloproteins is well established.

However, cases of excess intake of trace metal ions are credited with pathological events such as the deposition of iron oxides in Parkinson's disease [1].

In addition to aiding neurological depositions, these redox active metals ions have been credited with enhancing oxidative damage, a key component of chronic inflammatory disease [2] and a suggested

initiator of cancer [3].

As inflammation is a characteristic feature of a wide range of diseases, further potential pathological roles for metal ions are emerging as exemplified by premature ageing [4].

After Editing:

As for many food components, consuming metal ions can be precarious. Trace metals such as Fe and Cu ions help maintain normal body functions, such as the synthesis of metalloproteins. Studies, however, have linked excess intake to oxidative damage [2] and inflammation, and also specific conditions, including Parkinson's disease [1], cancer [3], and premature ageing [4].

Before Edits:

Immortality is an alluring concept. Some scientists believe that it will be possible to "upload" one's mind by recreating the circuitry of the brain in silico. Before we can upload brains, we first must reverse-engineer neural circuitry and begin by creating a circuit map.

Electron microscopy provides the only possible method through which we're able to clearly visualize synapses and follow neural processes. Volumetric reconstruction of neural tissue using electron microscopic resolution is necessary to map neural circuitry. Focused ion-beam scanning electron microscopy (Knott et al. 2008) gives excellent quality images, but fails to process tissue pieces larger than 40 microns in diameter. Thin sections imaged with transmission electron microscopy succumb to the damaging effects of manual handling and section distortion. Thus, it's most prudent to use a method that images the block-face directly and is capable of imaging large block-faces. Serial block-face scanning electron microscopy (SBEM; Denk and Horstmann 2004) provides both necessary components.

After Edits:

Some scientists believe immortality might be possible one day. They surmise that by recreating brain circuitry in silico, we can “upload” the mind. Before we can upload minds, we must reverse-engineer neurons and create a circuit map.

There are many types of electron microscopy devises that can provide methods to visualize synapses and follow neural processes. Volumetric reconstruction of neural tissues using electron microscopic resolution allows us to map neural circuitry. There are caveats to some of these devices.

Focused ion-beam scanning electron microscopy (Knott et al. 2008) provides quality images, but fails to process tissue pieces larger than 40 microns in diameter. The thin tissue images succumb to manual handling and section distortion. A method that images the block-face directly and that is capable of large block faces makes more sense. Serial block-face scanning electron microscopy (SBEM; Denk and Horstmann 2004) provides a sensible solution.

Before Edits:

Previous studies have consistently reported increased risk of subsequent drug use associated with conduct problems and antisocial behavior in childhood (1-5), and an association of drug dependence with conduct problems was found in a general survey of young adults (9). Furthermore, long-term relationships between aggressive, unconventional, and impulsive behaviors have also been found with drug use involvement generally (10-12). However, different pathways between early childhood misbehavior and drug involvement may exist. Psychiatric symptoms and cognitive disabilities may be manifest as aggressive behaviors and drug use may be a response to impulsive tendencies that often co-occur with aggression or misbehavior. Distress and failure to adopt responsible conventional roles and behaviors may be important mediators linking childhood misbehavior to late drug dependence (13,14).

After Edits:

Previous studies link an increase in drug use, including drug dependence, with early behavioral dysfunctions (1-5). Lengthy relationships between aggressive and impulsive individuals are linked to later drug use. However, different pathways exist between early childhood behavior and later drug use (10-12). Mental disabilities may manifest as aggression, and drug use is a way to self-medicate. Failure to treat these early behaviors is linked to later drug abuse.