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THE ROLE OF PROPRIOCEPTIVE FACILITATION AND ITS APPLICATION AS AN INDISPENSABLE PART OF PRACTICAL PHYSIOTHERAPY

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Abstract: The essence of proprioceptive neuromuscular facilitation consists in the application of specific reinforcement techniques to enhance central arousal by volitional movements to improve active capacity of the affected muscle and muscles groups. This is a method of rising the muscle reaction and volitional impulses, which can be reached during stimulation of proprioceptive nerve endings. Proprioceptive neuromuscular facilitation consists is a philosophy and a concept treatment (Kabat, 1950) and for the first time the method was applied in physiotherapy practice in 1947. Dr. Kabat and Maggie Knott was the founders which started and continued to expand the development of techniques. Nowadays patients with traumatic as well as orthopaedic symptoms are treated with this concept successful. Development of PNF concept followed some specific techniques and patterns responsible to the neuromuscular facilitation. Movements are our natural way to interact with our environment. Interactions are directed by the mechanism of motor learning principles includes a progression from hands-on to hands-off treatment strategy. The mean goal is functional oriented activities and independence. The physiotherapy should be focussed always to mobilize the reserves to reach the highest point of function. Especially in the first and cognitive stage of motor control, the therapists manual facilitation will be a helpful tool in reaching this goal (Adler et. al, 2007).

Keywords: PNF, neuromuscular facilitation, muscles.

Introduction

Our goal is to reach the highest functional level and maximal independence in activities of daily living, to increase the quality of life for each patient. On the level of participation, the patient should take a part in normal activities again. The physiotherapist will always integrate principles of motor learning and motor control in his PNF treatment to reach this highest functional level. (https://www.ipnfa.org/for-patients/)

Without denying the importance of passive movement of the treatment methodology, which aim is to preserve and increase joint's range of motion, Kabat et al support the thesis that passive movements with nothing they contribute directly to the volitional activity in motor units of muscles. When applying passive movements with help there are active only the small part of motor units in the relevant muscles or muscles groups (Kabat, 1958).

Kabat (fig. 1) and his school are directing their own scientific interest looking for physiological phenomena, to facilitate and strengthen the muscular response in weakened volitional movement (International PNF association, 2013).

As is known, the force of contraction of a muscle is determined by the number of active motor units (Гранит,1957).

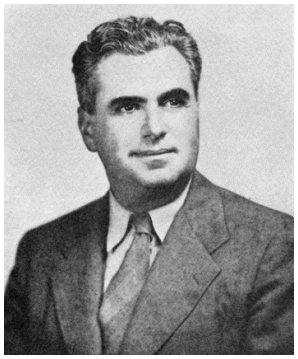

Fig 1. Dr. Herman Kabat - 1947, (Sandel, 2013)

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For greater precision the method of PNF can be defined as a means of increasing muscles reaction, relating to volitional impulses, which is achieved through proprioceptive nerve endings (Levine, Knott, Kabat, 1952).

"Noticebal muscle contraction is reached during contraction of more than 20% from motor units in one muscle", (Levine, Kabat, 1953) that's why PNF affects the impulses reaching central nerve system from the nerve ends in muscles, joints, and the labyrinth (Knott, Voss, 1956).

Materials and methods

A search was performed on PubMed, ScienceDirect, Google scholar, Researchgate et al.

Discussions

Facilitation means one muscle increasing response through the mechanisms of central nerve system (Kabat, McLeod. 1959).

For example, by hypotrophy some muscles groups, one systematic repetition to facilitate volitional contraction, can lied to a gradual decrease in synaptic resistance and the strengthening of volitional conduction pathways to these muscle groups. Later, because the result of PNF applying direct volitional contraction of the muscles is observed without any need for additional stimulation to facilitate it (Sirtori, Corbetta, Moja, Gatti, 2009).

As a common problem in the postoperative physiotherapy is the pathological increased muscle tone especially by the flexor muscles around elbow joint at the expense of weakened extensors, or as well as known muscle disbalance. Sherington studies reciprocal innervation and successive induction and found that reflex volitional contraction of a muscles leads to relaxation of antagonist muscles. The phenomenon is called reciprocal innervation. This is basic phenomenon of muscles activity allowing the performance of smooth and coordinated movements (Licht, 1984). Sherrington draws attention to the fact that immediately after triggering a reflex for example, the extensibility of the opposite is suppressed. It turns out that an active contraction of the motor muscle facilitates the subsequent volitional movement of the agonist (Sherrington, 1947).

The work of Sherrington was important in the development of procedures and techniques of PNF patterns. (Adler, Beckers, Buck, 2000).

It was found that with increasing of muscle elongation his willingness to respond to a standard cortical stimulus increase. Because of that reason in the developed by Nikolova (2019) methodology in the presence of flexion contracture in elbow joint stretching is not recommended. Interesting is the fact that any contraction or stretching of a muscle affects neighbouring muscles in a certain way. Experiment contributed by Gerhorn and Loofbarow (Ayres, 1959) about proprioceptive stimuli related to passive movements in the elbow joint or resistance of triceps brachii muscle indicates that in flexion from 115 in elbow joint m.triceps brachii, m.extensor carpi ulnaris and radialis have a significantly reduced threshold of irritability. In extension in elbow joint respectively opposite relations are observed, obvious activity of m.biceps brachii, m.extensor carpi radialis and m.brachioradialis. From these and further experiments of the authors it is proved that between some muscle groups there is a close functional connection. Thus, two or more muscles working together can be considered as a form/model of movement or a form of muscular joint activity. Experiments show that more activity can be created in one muscle with proprioceptive impulses caused in a muscle other than one's own. Hence the conclusion that each muscle of one limb is significantly affected in its activity from the proprioceptive impulses created by other muscles in the same limb. This is fundamental to the muscle's activity itself and for the targeted impact of certain muscles. From the above data can be stablished, that in their activity muscles do not work in isolation from each other and are in close functional relationships fixed in certain patterns of movement within in which one element creates favourable conditions for others, that means that facilitates their action. This is done mainly through proprioceptive mechanisms. Afferent impulses in one muscle facilitate the contractions of his synergists (Voight, Hoogenboom, Cook, 2008). Electro myographic research (EMG)of Levin and Kabat on patients shown that the position of joints facilitates muscles activity not only because of the factor "impact of stretching". If the forearm is in supination, m.biceps brachii is facilitated although in this position it is shortened (Levine et. al 1954).

„Diagonal/Spiral models of Kabat“ what is their purpose?

Kabat pays special attention to combined primary movements called motion patterns. The models are from simpler to more complex involving several joints and components. Kabat concludes that the diagonal-spiral models are the most effective. This is due to the close relationship with the spiral and rotational characteristics of the skeletal system-bones, joints, and ligaments structures. This type of movements is in harmony with their topographic location of the muscles from their initial and final insertion and with a structural characteristic on the individual muscles. The diagonal/spiral model of volitional movement is mean this movement which involve several joints simultaneously and three components: flex./ext./abd./ add./ ext./int. rotation (Kabat, 1958; Surburg, P. R., & Schrader, J. W. (1997). Each diagonal consists of two models of movements, and they are antagonistic each other, having one main component of flexion or extension. These basic components should be always combined with abduction/adduction or rotation. The diagonal/spiral patterns of movement using in PNF provide optimal opportunities for contraction of the main muscles performing the movement (Лиментал, 1963), (fig.2). One model of movement which is optimal for one whole “chain” of muscles, allows them to contract from their extended starting position to the point of maximum shortening, when the model is performed during full range of motion (Kabat, 1958).

PNF patterns can be used depending on the indications for the exercises like:

- free active movements
- passive movements for determine the range of motion or active movements with help
-active movements against resistance

Fig.2 Maggie Knott and Herman Kabat demonstrated diagonal/spiral models of movements,1950, Institute Vallejo, California, (Sandel, 2013).

Most popular and useful are the following models:

“switching antagonists“ - if it used in his full range of motion it’s working like proprioceptive facilitation also by the tensile factor at the time of the change of direction and by the applied resistance. It’s recommended the exercise with resistance to be repeated several times for the strongest antagonist and after that to perform the resistance movement for the weak agonist (Knott & Voss, 1956).

There are several varieties of pattern **“switching antagonists“** which are widely used in kinesitherapy practices

„slow reversal“- isotonic contraction of antagonists followed by isotonic contraction of agonists. Movements are performed slowly against the respective maximum resistance in accordance with the recovery stage. The movement with the stronger antagonists is done first, and then with the weakest which we want to strengthen.

„slow reverse-hold“- the difference here is that the patient must “hold” the isometric contraction. Immediately after detention is done isotonic contraction in opposite way, and by the end of the movement should repeat the same procedure.

„rhythmic stabilization“ – starting with one active isotonic contraction against resistance on agonists muscles , and in the strongest position of the volume of movement the patient must “hold” isometric. Follows one isometric contraction on weakness agonists against appropriate maximum dosing resistance. Followed by alternation of isometric contractions against maximum resistance on antagonists and agonists – rhythmic. Simultaneous strengthening of both movements is achieved. After the last isometric contraction on weakness muscles, the patient continued movement in one isotonic contraction. This model can be applied at any point of range of motion and is particularly suitable when patient experiences pain when performing movements. The described varieties on switching agonists are used

for strengthening of active movements add to increase the range of motion (ROM) in affected segment.

The following varieties are used as relaxing techniques to relax muscles with pathological increased tone.

„slow reversal-hold-relax“ – Isotonic contraction of the muscles that restrict movements is performed followed by isometric contraction on the same and then a short period of volitional relaxation of their antagonists. Relaxation must take place at the point from which the ROM of the antagonist muscles is further limited.

„hold-relax” - isometric contraction is performed against maximum resistance on muscle with increased tone according to the stage of treatment. Following by volitionally relaxation on those muscle, which can be performed with isotonic contraction on agonists. Patients with pain during stretching of the muscles with increased tone, this pattern can be just optional. For example, patients after immobilization because the fracture of radial head, often we can see the limitation of extension. The pattern applied on m.biceps brachii accompanied with slowly increased resistance can provide relaxation on the biceps, and in the same time stimulation on m. triceps brachii. Precise decision of suitability is required in cases where is vicious imbalance on antagonists.

PNF exercises are not allowed when the muscles are tired, because if one muscle does not respond maximum adequately as possible, the exercises will lose their original purpose (Розенблат, 1961, Kabat et. al, 1995). Otherwise they will be ineffective without satisfaction from patient's position (Банков ,1967).

“Contract-relax” Another technique is the contract-relax. It is almost identical to hold-relax, except that instead of contracting the muscle without moving, the muscle is contracted while moving. This is sometimes called isotonic stretching (Surburg & Schrader, 1997). Proprioceptive neuromuscular facilitation contract relax antagonist stretching technique was better than Proprioceptive neuromuscular facilitation hold-relax stretching technique in improving the hamstring muscle flexibility (Ramachandran et. al, 2018).

Conclusion

With great respect to priceless scientific contribution of dr. Herman Kabat, who continuous until nowadays and reaching the methodises increases the possibilities of physiotherapy where it is a major way of recovering. The goal of proprioceptive neuromuscular facilitation techniques is to promote functional facilitation, inhibition, strengthening and relaxation of muscle groups (https://www.slideshare.net/). The principles are based on concentric, eccentric, and static muscle contractions. These muscle contractions with properly graded resistance and suitable facilitatory procedures are combined and adjusted to fit the personal needs of each patient. (Adler, Beckers & Buck, 2007). We have grouped the PNF techniques so that those with similar functions or actions are together. Proprioceptive neuromuscular facilitation philosophy consist of positive approach: no pain, achievable tasks, set up for success, highest functional level, motor learning and mobilize potential. The effect of neurophysiological stimulus continues after stimulus stops. The feeling of increased power and ROM that comes after a maintained static contraction is a result different pattern. Last, but not least the treatment approach is always positive, reinforcing and using that which the patient can do, on a physical and psychological level. The primary aim of all treatment is to help patients to achieve their own highest level of function. To reach this highest level of function, the therapist integrates principles of motor control and motor learning (https://www.slideshare.net/). The proprioceptive neuromuscular facilitation concept provides us with many tools such as verbal and visual input, tactile information, and techniques like rhythmic initiation, combining of isotonic and replication to give the patient information about these activities. (Springer, Berlin, Heidelberg, 2008). But the therapist must decide when and how much external information the patient needs. With proprioceptive neuromuscular facilitation philosophy in mind, the physiotherapists will always give the best facilitation. At the end the patient must fulfil all activities independently and without our help (https://www.slideshare.net/).

The effects of PNF have been addressed in many studies, a systematic review of which has been made, for example, by Opplert et al. (2017). Proprioceptive neuromuscular facilitation can be a promising intervention, and severalstudies have investigated this subject in the past fiftheen years (Lazarou et. al, 2017; Padua et al., 2004 ; Takasaki, Okubo & Okuyama, 2020).

It may be possible that PNF contributes to enhancement of the JPS, but the effect of PNF on the JPS is hypothesized to different with different techniques, body regions, and physical problems (Takasaki, Okubo & Okuyama, 2020).

In this publication, we tried to emphasise the broad-spectrum application and the neurophysiological

foundation of Proprioceptive neuromuscular facilitation to be of maximum assistance to practicing colleagues in the various fields of Physiotherapy and Medicine.

References

Adler, S. S., Beckers, D., & Buck, M. (2007). *PNF in practice: an illustrated guide.* Springer Science & Business Media.
Adler, S.S., Beckers, D., Buck, M. (2000). Introduction to Proprioceptive Neuromuscular Facilitation. In: *PNF in Practice*. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-662-04134-5_1
Ayres, J. (1959), Proprioceptive Erleichterungsmet-hoden. *Krankengymnastik,11*, 10, S 181-185
Kabat H. (1950). Central mechanisms for recovery of neuromuscular function. *Science (New York, N.Y.), 112*(2897), 23–24. https://doi.org/10.1126/science.112.2897.23
Kabat H. (1961) Proprioceptive facilitation in therapeutic exercise. Ir.: Licht E, ed. *Therapeutic exercise.* 2nd ed. New Haven: E Licht,.
Kabat H, McLeod M, (1959). Athetosis: Neuromuscular dysfunction and treatment. Arch Phys Med Rehabil;40(7):285-292.
Kabat H., (1958) Proprioceptive facilitation in therapeutic exercise. In: Licht SH, ed. *Therapeutic Exercise.* New Haven, CT: Elizabeth Licht, p. 301
Kabat, Mc. Lood, Holt, (1995) . *The Practical application of Proprioceptive Neuromuskular Fasilitation*, p.125-135, Physiotherapy
Knott M, Voss DE., (1956) Proprioceptive Neuromuscular Facilitation: Patterns and Techniques. New York, NY: Hoeber-Harper; p. 179-195
Lazarou L, Kofotolis N, Malliou P, Kellis E. Effects of two proprio-ceptive training programs on joint position sense, strength, activationand recurrent injuries after ankle sprains.*Isokinet Exerc Sci. 2017*; 25:289–300. https://doi.org/10.3233/IES-1711466.
Levine, M. G., Knott, M., & Kabat, H. (1952). Relaxation of spasticity by electrical stimulation of antagonist muscles. *Archives of physical medicine and rehabilitation, 33*(11), 668–673.
Levine, M. G., & Kabat, H. (1953). Proprioceptive facilitation of voluntary motion in man. *The Journal of nervous and mental disease, 117(*3), 199–211. https://doi.org/10.1097/00005053-195303000-00002
Levine, M. G., Kabat, H., Knott, M., & Voss, D. E. (1954). Relaxation of spasticity by physiological technics. *Archives of physical medicine and rehabilitation, 35*(4), 214–223.
Licht, S. (1984). History. In Basmajian JV (Ed.) *Therapeutic Exercise* (4th ed.) Baltimore: Williams & Wilkins, Ch1.
Opplert, J.; Babault, N., (2017). Acute Effects of Dynamic Stretching on Muscle Flexibility and Performance: An Analysis of the Current Literature. *Sports Med. 2017, 48*, 299–325
Padua, D. A., Guskiewicz, K. M., Prentice, W. E., Schneider, R. E., & Shields, E. W. (2004). The effect of select shoulder exercises on strength, active angle reproduction, single-arm balance, and functional performance. *Journal of Sport Rehabilitation, 13*(1), 75-95.
Ramachandran S, Paul J, Senthilkumar N, Sudhakhar S, Tamilselvi. Comparative effect of PNF stretching techniques on hamstring flexibility. *International Journal of Medical and Exercise Science. 2018; 4*(1): 443-447
Sandel M. E. (2013). Dr. Herman Kabat: neuroscience in translation … from bench to bedside. *PM & R : the journal of injury, function, and rehabilitation, 5*(6), 453–461. https://doi.org/10.1016/j.pmrj.2013.04.020
Sirtori, V., Corbetta, D., Moja, L., & Gatti, R. (2009). Constraint-induced movement therapy for upper extremities in stroke patients. *The Cochrane database of systematic reviews, (4),* CD004433. https://doi.org/10.1002/14651858.CD004433.pub2
Sherrington, C., (1947). The Integrative Action of the Nervous System. New Haven, CT: Yale University Press.
Springer, Berlin, Heidelberg, (2008), Activities of Daily Living. In: *PNF in Practice*. https://doi.org/10.1007/978-3-540-73904-3_14
Surburg, P. R., & Schrader, J. W. (1997). Proprioceptive neuromuscular facilitation techniques in sports medicine: a reassessment. *Journal of athletic training, 32*(1), 34–39 https://doi.org/10.1080/00913847.1981.11711162
Szafraniec, R., Chromik, K., Poborska, A., & Kawczyński, A. (2018). Acute effects of contract-relax proprioceptive neuromuscular facilitation stretching of hip abductors and adductors on dynamic balance. *PeerJ, 6, e6108.* https://doi.org/10.7717/peerj.6108
Takasaki, H., Okubo, Y., & Okuyama, S. (2020). The Effect of Proprioceptive Neuromuscular Facilitation on Joint Position Sense: A Systematic Review, *Journal of Sport Rehabilitation, 29*(4), 488-497. Retrieved Apr 21, 2022, from https://journals.humankinetics.com/view/journals/jsr/29/4/article-p488.xml
Voight, M. L., Hoogenboom, B. J., & Cook, G. (2008). The chop and lift reconsidered: integrating neuromuscular principles into orthopedic and sports rehabilitation. *North American Journal of Sports Physical Therapy: NAJSPT, 3*(3), 151.
Банков С, (1967). *Кинезиологични бележки и упражнения по лечебна физкултура за различните движения в лакътна става*. Приложение към“ Бюлетин по курортология, физиотерапия и лечебна физкултура“
Гранит Р., (1957). *„Електрофизиологическое исследование рецепции“/*перевод с английского/ И. Л. Москва, стр. (191-217)
Лиментал Б., (1963). *Материали от курса по проприоцептивно нервно-мускулно улесняване, проведен в Прага*, ЧССР през месец Октомври
Николова А., (2019). Следоперативна кинезитерапия при фрактури в лакътна област, *Дисертационен труд за присъждане на ОНС „Доктор“* ,стр. 38.1.6; Благоевград
Розенблат В. В., (1961). *Проблема утомления.* — Медгиз: Медицина, стр. 149
International PNF Association. (Accessed May 9 2013), http://www.ipnfa.org/index.php?id=113
https://www.ipnfa.org/for-patients/
https://www.slideshare.net/