



CISM INTERNATIONAL SYMPOSIUM
PRETORIA - SOUTH AFRICA
1996

THE PROCESS OF LEARNING AND OPTIMALIZATION OF MOVEMENT

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INTRODUCTION

Movement of the human skeleton, is quite literally, based on the combined operation of the physical principles. Levers, force vectors, force of gravity, line of gravity, law of inertia and acceleration are but just a few of the factors influencing the biomechanics of movement. The anatomical structure of the joint, the flexibility of the muscle and joint, and joint stability, determine how these physical principles would be acting on the body to bring about movement.

Movement itself is a composition of different components of movement taking place at each joint, which acting together with other joints brings about the flowing type of movement witnessed. Movement occurs either at the transverse, frontal, or sagittal planes, meaning that a body segment is being rotated about its axis, moving through a path that is parallel to one of the three cardinal planes. While the movement is not limited to these paths, the system of planes and axes provides a simple way of describing movement at a given joint. For example, movement in the transverse plane around a vertical axis is generally termed medial or lateral rotation, while flexion and extension occurs in the sagittal plane and abduction and adduction occurs in the frontal plane.

All functional movement is to an extent performed with some degree of rotation. The extent thereof is dependant on the structure of joint surface and the arrangement of the muscles and ligaments. Rotation forms the transitory plane within a movement, normally being the mid phase in the analysis of the components of movement.

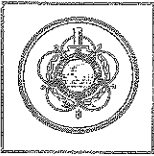
MUSCLE FUNCTION IN MOVEMENT

"The most important characteristic of a muscle is it's ability to develop tension and to convert a force on a bony lever."⁽¹⁾ The tension developed within a muscle is initiated by the crossbridge formation and movement of actin and myosin. "The amount of tension that a muscle can generate depends on the frequency, number and size of motor units that are firing, and at the sarcomere level, on the number of crossbridges that are formed."⁽¹⁾ That is, at optimal length the actin and myosin filaments are so positioned that a maximum number of crossbridges are formed.

The second factor important in movement is the flexibility of the muscle. Limitation results in a shorter distance being travelled through the arc of movement, compensation taking place at other parts, thus altering the biomechanics of the movement.

JOINT FUNCTION

There is a close relationship between the joint structure and it's function. Function is possible based on the design of the joint, but then the design of the joint surface is formed by the stresses placed on it. The function of a joint is twofold, namely to provide stability and to allow movement, the design of the joint being different for both.



JOINT STABILITY

A joint forms the foundation from which all movement is directed. An unstable joint during movements results in the line of gravity moving around and in many instances falling outside the base of support. Therefore the stability of the joint is equally dependant on the muscles working on the joint and at the same time the joint being displaced through the action of the muscles.

It is therefore clearly evident that movement is based on the physical principles and that injury to the body would drastically affect movement. The rehabilitation process must in it's final stage ensure that the sports person has full range of painfree movement and that all movements pertaining to this sport is economically perfected. The use of PNF in the rehabilitation process has proved to be of great value to physiotherapists in the treatment of sports injuries.

WHAT IS PNF?

PNF stands for:

P = PROPRIOCEPTIVE

N = NEUROMUSCULAR

F = FACILITATION

P = PROPRIOCEPTIVE

The proprioceptor is a receptor that is located within the tissues of the body (e.g. muscles, tendons, and joints). They are associated with muscle tone, posture, movement and co-ordination.

N = NEUROMUSCULAR

Referring to the nerves and muscles.

F = FACILITATION

Facilitation means "the effect produced in nerve tissues by the passage of an impulse. The resistance of the nerve is diminished so that a second application of the stimulus evokes the reaction more easily."(3)

Historically, the PNF technique was developed at the Kabat-Kaiser Institute over a period of five years, 1946 - 1951. The technique involves the rehabilitation process using purposeful movement in the primitive functional patterns that man uses in his everyday life to carry out his duties. For example, a straightforward activity like walking involves various components of movements; first flexion at the hip and knee accompanied with slight rotation of the hip followed by extension of the knee and dorsiflexion of the foot prior to heel strike. The philosophy of treatment using PNF is: that it can increase the potential and the skill of the existing movement. That the movement trained is more specifically goal directed, the strength together with the co-ordination of movement can be improved anywhere within the range of movement and that weaker parts can be strengthened through the co-operation of stronger parts.



THE TECHNIQUE INVOLVES:

The application of maximal resistance throughout the range of movement.

The positioning of a part to obtain a stronger contraction.

The movement is performed first in the strongest part of the range, progressing to weaker parts of the range of movement.

Stretch is applied to the groups of muscles, usually synergist, for greater proprioceptive stimulation.

Overflow of work from other muscle groups is used for reinforcement. The use of repeatedly contracting the muscles to improve the range as well as to improve endurance.

Stimulation of the myotatic reflex in the treatment program.

The myotatic reflex.

When a muscle is stretched, it contracts - the response is called the stretch or myotactic reflex which is responsible for the preservation of basic muscle tone. The myotactic reflex is an important stabilising mechanism and is particularly important with regard to the maintenance of a normal body posture against gravity. During the static myotactic reflex the stretch on the muscle spindle causes shortening of the muscle and via the "gamma loop" the muscle spindle is repeatedly stretched by the contraction of these fibers. The phasic myotactic reflex in the antagonist muscle slows down the rapid movement produced by the agonist group

PRINCIPLES OF PNF PATTERN OF MOVEMENT

PNF techniques are conducted in the patterns of movement. "Mass movement is characteristic of normal motor activity and is keeping with Bevor's axiom that the brain knows nothing about individual muscle action but known only of movement."(4) In performing any functional activity specific combinations of movement are utilized through the specific sequence of muscles primarily responsible for movement. The patterns of movement are spiral and diagonal in character, in keeping with the spiral and rotary characteristics of the skeletal system and the alignment of muscles from origin to insertion. "Each spiral and diagonal pattern is a three-component motion with respect to all of the joints or pivots of action participating in the movement. The spiral and diagonal patterns of facilitation provide for an optimal contraction of major muscle components. A pattern of motion that is optimal for specific "chain" of muscles allows these muscles to contract from their completely lengthened state to their completely shortened state, when the pattern is performed through the full range of motion."(4) The three components of movement in any functional activity include either flexion or extension, movement towards and across the midline or across and away from the midline, and rotation.

MANUAL CONTACT

The use of "hands on" provides the facilitating mechanism. Through direct contact with the patient the physiotherapist does not only give maximal resistance, but is also able to direct the movement through the correct pattern.

COMMANDS TO THE ATHLETE

Verbal commands acts as a added form of stimuli. Tone of voice may influence considerably the quality of response. Strong, sharp commands stimulate a stress situation and are used when maximal stimulation of active motion is desired. The action commands are clear, concise, accurate and timed to the physical demands. "Push" or "pull" are commands for isotonic contraction. "Relax" or "let go" are the commands for voluntary relaxation. The timing of the action command is extremely important as a premature command results in poor initiation of movement by athlete and loss of control of movement



by the physiotherapist. Whereas a delayed command will result in a lessened response especially where a stretch stimulus is being used.

STRETCH STIMULUS

A stretch stimulus applied at the beginning of the pattern, in the extreme lengthened range of that pattern, provides a stronger response. The stretch applied is quick and painfree and immediately follows with command to either "push" or "pull".

TECHNIQUES OF EMPHASIS REPEATED CONTRACTIONS

Repetition of activity is necessary to the learning process, the development of strength and endurance. Repeated activity of the weaker major muscle components of a pattern is obtained through a technique of emphasis, repeated contractions. In order to emphasize the response of a weak component of a pattern, or a weak pattern, movement is repeated until fatigue is evident in the performance of that movement. Once the athlete has performed the movement against resistance with resultant overflow to a weaker pivot of action, he is instructed to "hold", with an isometric contraction, at the point where a lessening of power is felt. The resistance is maintained at the stronger part and the therapist then resists more strongly at the weaker part, instructing the athlete to "pull again" or "push again", thereby shifting from an isometric contraction to an isotonic contraction.

HOLD - RELAX ACTIVE MOVEMENT

This technique provides repetition of isotonic contraction without sustained effort. The physiotherapist first elicits an isometric contraction in the shortened, painfree range of pattern. When the "hold" is secured and resisted strongly, she commands the athlete to "let go". As soon as the athlete has relaxed his "hold", she immediately and quickly moves the part passively into the lengthened range of the pattern and instructs to "pull" or "push" again. This procedure is repeated several times until a build-up in power is felt to occur, or until fatigue settles in.

CONCLUSION

The use of PNF in the rehabilitation process of sports injuries is invaluable as it can be used to improve strength, endurance and coordination within the full range of the functional movement.
