

Comes a woman to the physiotherapist.....

Case report of a useful treatment strategy for a long term total hip replacement with muscular instability.

Abstract:

Context: The use of the PNF concept or components of the PNF approach is widely spread among physiotherapists all over the world. In modern times Evidence Based Physiotherapy (EBP) is a standard of making the therapy more transparent. Therefore external support for the chosen treatment management is necessary. This case report tries to show a possible way of doing that.

Objectives: To show the clinical reasoning process at the hand of an example of a case.

Method: This report concerns a patient with a total hip replacement of 16 years ago, with secondary problems in functioning. In this case we searched journals and databases to find out to which extend the PNF concept is described and proven to be beneficial for this patient.

Results: We found general and specific publications. The gained information was supporting the patient management. The treatment outcomes helped the patient to improve quality of functioning.

Conclusion: There is documented support for the PNF concept as an approach for physical rehabilitation in specified disorders, this is also the case for manual mobilization techniques. Both seem good applicable in a complex case, where spine and muscle function impairments build the basis for activity limitations.

Introduction:

With the use of the PNF concept a variety of sub goals can be achieved. These range from improvement of strength, ROM, coordination, etc. up to functional activities. In this way one can work on every level of the ICF with the PNF concept. In searching publications concerning the efficacy of the PNF method we soon run into smaller studies, which illustrate the variety of applicability¹⁻⁷. To illustrate the broad possibilities of the PNF concept this article deals with a case report in which a total hip rehabilitation plays a central role.

An older woman, 62 years of age with a total hip replacement right calls in for physiotherapy. The complains are specified on activity level within the

ICF. She complains about the walking distance and endurance she is able to achieve. The experienced problems are expressed in the maximal gait distance of +/- 800 meters. For a longer distance she is faced with pain in the right hip, groin and lumbar spine on the right side. The amount of pain is indicated with VAS 7,4 on a analogue unnumbered line of 10 cm. An other specific problematic activity is ascending stairs.

The patients history tells us about her hip replacement 16 years ago. This was necessary after developing degeneration of her right hip after giving birth to her son 28 years ago. After her operation she developed weakness in the left leg due to nerve entrapment on level L3/L4. Also a scoliosis became part of her problems.

To obtain a better impression of the patients problems a gait and posture observation was executed.

The stance position show's a asymmetry towards the left side companioned with a left convex scoliosis in the lumbar spine. During the gate, a strong Trendelenburg lurch compensated with the sign of Duchenne was strongly present. The step length was short on both sides and the inter foot distance was nihil. This means that the patient walked with strong adduction in stance phase as well as in swing phase. Mainly on the right side, which may explain a part of the scoliosis .

The gait analysis shows us main problems during the mid stance ^{12, 13} on the right leg. In this phase there is a clear pelvis drop on the left side causing a scoliosis moment in the lumbar spine with a left convex curve. Also the right knee shows a medial collapse, caused by the weak abductors and resulting in a valgisation of the ankle and causing a flat foot. The left leg is weak in the terminal stance and pre swing^{12,13}. In these phases, together the push off phase, there is need of extension force in hip, knee and ankle with abduction stability in the hip¹⁴. The left leg shows in this patient a weak extension of hip and knee, a short push off and therefore a short step length in the right leg. Because of these issues the patient walks with a great deal of instability, proven by the sign of Trendelenburg on the right side and with the sign of Duchenne on the left side. According to the study of Vogt ea.¹⁵ this is significant more present in patients after a total hip arthroplasty.

Focused on this, the physical assessment was carried out.

Based on the observation and analysis of the gait and posture the muscle strength of hip abductors and extensors, trunk extensors and abdominal muscles seems to be indicated to be tested. The degree of posture disturbance had to be determined by assessing the range of motion (ROM) of the hips and the spine.

Within the PNF-concept we are looking for strong body parts to influence the weak(er) body elements using the basic procedure of irradiation and overflow^{8, 9, 10}.

The TGUG test took 12 seconds, which is just out off the normal range of up to 10 seconds¹¹.

In the testing exercise of "lifting" towards the right side the scoliosis was corrected. This shows us that the posture disturbance is one of the first degree (able to be corrected actively)



Figure 1: Correction of scoliosis with "lifting"

I also got an impression of the strength of the trunk extensors and the coordination of trunk with stabilizing the pelvis and left leg. The general trunk strength of extensors and pelvis stabilizers is muscle force 4. The left leg dropped into adduction during the lifting activity, showing weak abductor activity and weak coordination in stabilizing the leg - pelvis junction with hip extensors and abductors. The passive flexion mobility of the right hip is limited at 90° and the extension fails 10°. Lumbar p/a pressure provokes local pain at levels L1, L2, L3 and S1. Lateral flexion to the right side is painful in the lumbar spine, to the left side the lateral flexion is limited by 20°. Axial spine compression is painful and Kemp test right side is more painful. This is indicating inter vertebral joint irritation, possibly because of degeneration. The SLR test is on the left 200 limited compared to the right side and provokes a "pulling" sensation down into the lateral lower limb. A nerve entrapment would be a possible explanation.

The physiotherapeutic diagnosis was formulated:

Woman, 62 years of age with gait complains concerning her walking distance. These complains are based upon weak hip muscles right sided because of a total hip 16 years old, and weak muscles left because of nerve entrapments L3/4. Besides that there is a scoliosis based upon weak coordination of trunk and leg muscles. Social participation is limited in terms of problems with shopping and leisure walks.

The above mentioned assessment results indicate that there is mainly an active instability, due to muscle weakness and weak coordination. This is causing an overuse in the lumbar intervertebral joints^{20,23}, which explains the low back pain. The physiotherapeutic treatment plan exists based upon these results out of the following sub goals:

Main goal: Return to shopping and leisure walks with distances of 2000 meters or more.

Sub goals: 1) repositioning of the spine during sitting, stance and gait; 2) repositioning of the hips during stance and gait; 3) pain relieve; 4) strengthening of the trunk extensors, abdominal muscles, hip abductors and left leg extensors; 5) stabilization of the positions mentioned in 1 and 2; 6) coordination exercise to keep dynamic stability during sitting, stance and gait.



Figure 2: The patient with scoliosis developed after THA

To achieve the stated sub goals I used the following interventions: manual mobilization of the lumbar spine and hips, and PNF exercise therapy (this will be specified in this article).

Supporting literature.

In the ideal world the evidence based practicing therapist would have direct access to all RCT 's and systematic reviews. For this there are many barriers. It occurs that the ideal world for the EBP therapist does not exist¹⁶. To check if the chosen treatment strategy is the right one, I searched for indications in literature. I used for this the journals: "manual therapy", "Fysiopraxis", "The Dutch journal for physiotherapy", the IPNFA website and the database "Medline". I used the following search terms: *total hip, total hip and gait, hip instability, instability, scoliosis, proprioceptive training, motor control, PNF training*. With this I think that I checked for the Dutch physiotherapist a representative amount of accessible sources.

The text of Johnson and Johnson⁹ provides us with general guidelines to apply PNF-exercise therapy and manual therapy in case of lumbar instability.

Panjabi¹⁷ explains that every movement segment depends on three subsystems, the passive, the active and the neural subsystem. The active subsystem is build by the muscles and tendons around the spine, pelvis and hip joint and the muscles performing the gait. Local stabilizing muscles are mainly responsible for the positioning and stabilization of the joints. The passive subsystem exists from non contractile supporting structures, like ligaments, discs, joint shape etc. The neural or controlling subsystem is a

essential link between the active and passive subsystem. The proprioception plays an important role in the guidance of muscles. An intact joint position sense enables joint stabilization and accurate muscle activity to execute smooth movements. In case the active and neural subsystem do not function optimally the passive subsystem becomes overused and can get irritated.

The functionality and dynamic stability of the weight bearing complex is ensured by local stabilizers and global mobilizers (Hodges, Richardson, and O'Sullivan *et al*^{18, 19}). For the functionality the spine, pelvis and hip joints can not be seen separately from each other in terms of stability or even the anticipating stability of the lower extremities. This System has to be trained as one, in a variety of situations.

Maitland²⁰ describes manual mobilization techniques to improve lumbar mobility, with these techniques the trophic conditions of the lumbar spine can be influenced positively. Mulligan^{21,22} explains that the manual glide can be combined with active exercise. Now based on proprioceptive guidance muscle activity is build up in the maintained position. He uses the term SNAG 's (sustained natural apophyseal glides) During these maintained passive glides the patient is instructed to execute active exercises.

The study of Shimura and Kasai⁵ shows clearly that the PNF positions and exercises are of benefit for initiating movements. They measured the effect on EMG reaction time and motor evoked potentials, both were positively influenced by the PNF positions.

Comerford and Gibbons²³ point out that the rotation component is essential in making dissociated movements. In case the eccentric contractions of rotatory muscles is badly coordinated this results in local or segmental instability. The PNF-concept is emphasizing the rotation component in all executions of movements. Kofotolis showed that the PNF stabilizing techniques are beneficial for women with lumbar instability³.

The studies on gait training using the PNF concept all state a positive influence on gait parameters, like speed, cadence, step length. Although the studies were performed on patients with other indications (Stroke⁶ and amputation⁷) the basic conclusion is that the specific PNF approach was the essential part to improve the gait quality.

Based upon this biomechanical reasoning and the positive tests it seems that in this case an irritation of the capsule and ligamental system of the joints in the lumbar spine and hips itself developed on a lumbar instability and on hip instabilities. From a retrospective study of Marks²⁴ it is evident that science especially holds the proprioceptive part of the muscle responsible for position sense. The PNF approach especially uses proprioceptive facilitation to activate the neuromuscular system and to improve with that the coordination during movement^{8, 9, 10}. There are surely more methods to think of, which make this possible. Nevertheless the chosen performance is building up preconditions and is very functional oriented.

The treatment.

The patient received twice a week treatment during six weeks. Manual mobilizations of the lumbar spine were performed. During the p/a glides the patient did active extension exercises, in a way that SNAG 's^{21,22,25,26} of Mulligan were used. Besides that the patient was trained in posture and activities with focus on strengthening and coordinating the muscles with the PNF concept.

PNF strategy^{8, 9, 10, 27}.

In side lying the trunk elongation of the right side was exercised, using pelvis posterior depression with scapula anterior elevation. This was enhanced with the extremity patterns extension / abduction / medial rotation with knee extension and flexion / adduction / lateral rotation of the arm. These movement patterns trained the muscle groups discussed above, special focus on the intra- and intermuscular coordination was achieved with the technique combinations of isotonic. Furthermore the trunk elongation was stimulated with breathing facilitation on the rip cage.



Figure 3: Trunk elongation in side lying + breathing.

In supine the trunk stabilizers were emphasized using bilateral leg patterns which irradiate into lower abdominals. With this procedure the lower trunk regained strength to improve posture and stability.

In half standing the preparation for functional activities like gait and ascending stairs was executed. In this position similar patterns like in side lying were used to train the stability. Now the emphasis was on stabilization of the weight bearing joints, using the techniques stabilizing reversals, rhythmic stabilization and again combinations of isotonic. With these techniques we train especially the muscle sense and the awareness of positions of the joints towards each other. In terms of motor learning, knowledge of performance is depending on position sense. This position sense is mainly depending on the muscular proprioception (Marks²⁴).

From preparation of functional activities we have to go into the functional activities²⁷, in this specific case; gait training. Regarding the therapy management described above, I followed the ideas of motor learning to build up repetitions without repeating. This means that repetitions are done, but in slightly different situations and manners²⁸. Like Bernstein already stated in 1967, repetitions without repeating. The central nervous system needs variation since the controlling system is not dealing with muscles but rather with goals and activities¹³. Within the PNF gait training emphasis is possible on each phase like they are described by Perry¹³. Within each phase it is possible to emphasize on either ROM, muscle coordination or strength. Using the basic procedures of approximation, resistance, body



Figure 4: Half standing with trunk correction and left leg emphasis.

mechanics, lumbrical grip in the rhythm of gait, training of functional gait and ascending stairs was executed with the patient^{8,9,10,27}.

With this the coordinative guidance and specific muscle setting of the pelvic girdle can be taught and exercised in a goal oriented and controlled way. To achieve this, the techniques "Rhythmic Initiation" and "Combinations of isotonic" were used. The basic procedure of "Timing for Emphasis" enables it to emphasize components of the pattern^{8,9,10,27}. In this case the stabilization of the pelvis is essential. This was exercised with emphasis by building up a "hold" in

anterior elevation of the left pelvis, on which the patient could train the above mentioned activity. Because of the functional situation, we realize by using this pattern the abdominal activation to stabilize the lower trunk and the stabilization of the right hip in the gait phases mid stance and terminal stance. In the closed chain the anterior elevation automatically initiates extension and abduction on the contra lateral side.

After the first two treatment sessions, in which mobilization was the main treatment goal the emphasis was shifted on coordinating the necessary muscle activity to stabilize the lower trunk and hips. In the last two weeks the main objective shifted to the functional activities of gait and walking stairs.

The patient got home exercises, with "theraband", so she could do similar PNF exercises at home.

The result:

After the third treatment the patient was able to keep her posture in sitting and standing a prolonged time and the pain was dropped to VAS 3,4. After the fifth treatment the walking distance was more comfortable. At the end of the treatment sessions, the walking distance was increased to 2230 meters before pain increased up to VAS 6,7. The severity of the Trendelenburg

lurch and the sign of Duchenne were strongly diminished and the inter foot distance was increased by +/- 3cm.

Finally.

The chosen treatment strategy lead to a positive result for the patient and the therapist. The expertise and with that the knowledge, skill and experience of the therapist is within the manual therapy and the exercise therapy with the PNF concept. Several publications indicate that several sub goals can be achieved with PNF exercise therapy¹⁻⁷. Nevertheless it is a given situation that there are just a few to no bigger RCT 's published concerning the PNF concept. Especially not in relationship with the topic described in this case. There will be other therapy approaches possible to obtain similar treatment outcomes.

Nevertheless, taken in account that: the choice of the best treatment (EBP) is an integration of scientific research outcomes on the one side and knowledge, skill and experience of the therapist on the other side, in adjustment with the values and objectives of the patient¹⁶, the above described treatment approach is a well accountable therapy strategy.

Fred Smedes
Physiotherapist, manual therapist
Saxion; university of applied sciences.
IPNFA-instructor.
Practicing in private clinic.

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Appendix

Timing: A term, which describes coordination and the order of movements. **Normal Timing** describes the *visual* order of movements within a pattern. Movements do start distal and develops proximally. When **Timing for Emphasis** is used, the order of movements is stopped and specific one component of the total movement is exercised. Yet several techniques can be used. In this way an inter- or intramuscularly coordination deficit can specifically be treated.

RHYTHMIC INITIATION

Definition: A technique, for the goal oriented movement (Agonistic), in which rhythmic movements are performed in the full range of motion. It consists of four phases
 1) Passive; 2) Assisted; 3) Resistive; 4) Active.

Goal: learn a new movement
 Improve the intra- and inter muscular coordination
 Automation of a movement
 Tone Regulation

COMBINATIONS OF ISOTONICS

Definition: A technique for the agonists, in which concentric, eccentric and static contractions are combined, without loss of tension.

Goal: Improvement of eccentric control
Endurance improvement
Intra- and inter muscular coordination
Functional exercising

STABILIZING REVERSAL

Definition: A technique to improve the steadiness/stability of positions in which Agonists and Antagonists contract in a reversal without relaxation in between. There is a reversal of grips.

RHYTHMIC STABILISATION

Definition: A technique to improve the steadiness/stability of positions in which static contractions of the Agonists and Antagonists are build up without relaxation in between. There is no change of grips.

Goal: Improvement of stability
Improvement of posture control and balance
Improvement of coordination
Stimulation of deep sensibility, proprioception

Overflow. The effect that occurs based upon ongoing nerve impulses to synergistic muscles (irradiation). Because of this there is a greater effect than only in the muscles which are directly involved in the exercise.