

## Effectiveness of Physical Rehabilitation and Electro-Stimulation after Hip Joint Replacement Surgery

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**Abstract:** The ultimate goal of physical rehabilitation is to return the injured participant to pain free and fully functional activity (normal joint range of motion (ROM), flexibility, muscular strength). Electro- Stimulation is commonly used to strengthen weakened thigh muscles (quadriceps and hamstring). Joint replacements are common procedures and treatment of choice for those with intractable joint pain and disability arising from arthropathy of the hip. The purpose of this experimental study was to evaluate the effectiveness of physical rehabilitation and electro- stimulation (50/Hz/sec) after discharge from hospital on pain and function of range of hip joint motion and muscle strength for osteoarthritis patients following elective primary total hip replacement. Five female patients who had undergone hip joint replacement surgery were placed in a physical rehabilitation program and electric- stimulation to evaluate the effectiveness of these two muscle-strengthening protocols. Patients used simultaneous contraction of quadriceps femurs and hamstring muscles during a combined program (physical exercise and electro- stimulation) five times a week for 3 months. After patients completed the program, bilateral maximal isometric measurements of gravity-corrected hip extension and flexion torque were obtained; EMG and assess pain for the group and percentages were calculated to compare with the non-affected extremity. Results showed that patients after finished 12-week program with higher percentages for both extension and flexion torque when compared with the other extremity measurements flexion and extension. These results indicate that patients in this program can achieve high individual thigh musculature strength, hip range of motion and decreased pain.

**Key words:** Physical rehabilitation % Electro- stimulation % Hip Joint replacement surgery % EMG

**Abbreviations:** OA: Osteo-arthritis, THA: Total hip arthroplasty, VAS: Visual analogue scale, ROM: range of motion, EMG: Electromyography, NMES: Neuromuscular electrical stimulation

### INTRODUCTION

Total joint replacement (THA) or arthroplasty represents a significant advance in the treatment of painful and disabling joint pathologies. Total joint replacement can be performed on any joints of the body, including the hip, knee, ankle, foot, shoulder, elbow, wrist and fingers. Of these procedures, hip and knee total joint replacements are by far the most common. The number of joint replacements that are performed annually has been increasing steadily. In 2004, 234,000 total hip replacements were performed in the United States [1]. Osteoarthritis (OA) is the commonest cause of disability in older people. Prevalence figures for hip osteoarthritis range from 7-25% in people aged over fifty five with over 70% of sufferers experience pain and limitations in performing activities of

daily living, such as mobility outside the home. Effective treatment exists for end-stage disease in the form of joint arthroplasty. The number of primary total hip replacements reported for England and Wales in 2006 [2]. Electronic Muscle Stimulation, neuromuscular stimulation therapy or EMS: This type of stimulation is characterized by a low volt stimulation targeted to stimulate motor nerves to cause a muscle contraction. Contraction/relaxation of muscles has been found to effectively treat a variety of musculoskeletal and vascular conditions. Neuromuscular electrical stimulation (NMES) been used for many years by physical therapists to retard atrophy in enervated muscle and to maintain or improve muscular strength in immobilized muscle following surgery [3]. In the 1960's, Kots used NMES with elite athletes in the former Soviet Union (Kots) and found

strength improvements of 30-40%, using what came to be known as "Russian stimulation". He even suggested that NMES might be more effective than exercise alone for strength development in this direct current low volt 50 Hz/sec which called "stimol '1'" referred to Kots and based on stimulate the all muscle fibers' cells in the same time, that can be stimulated during current transmission when stimulated, the spindle sensory fibers discharge and through reflex action in the spinal cord initiate impulses to cause the muscle to contract reflexively, thus inhibiting the maximal contraction. This Russian muscle stimulation is commonly used to prevent or retard disuse atrophy, strengthening programs, reeducate muscles, post orthopedic surgery, joint replacement, gait training, shoulder subluxation and reduction of muscle spasms [4]. An electromyogram (EMG) is a test that is used to record the electrical activity of muscles. When muscles are active, they produce an electrical current. This current is usually proportional to the level of the muscle activity. An EMG is also referred to as a myogram. EMGs can be used to detect abnormal electrical activity of muscle that can occur in many diseases and conditions, including muscular dystrophy, inflammation of muscles, pinched nerves, peripheral nerve damage (damage to nerves in the arms and legs) and others [5]. The purposes of the study is to investigate the effectiveness of the physical rehabilitation and electro stimulation after hip joint replacement surgery by measuring:

- C Effect of physical rehabilitation and electro-stimulation on pain reduction to the injured extremity.
- C Effect of physical rehabilitation and electro - stimulation on femoris muscles' strength to the injured extremity.
- C Effect of physical rehabilitation and electro-stimulation on the hip joint range of motion to the injured extremity.

#### **Hypotheses:**

- C There will be significant statistical differences in the pre-tests and post- tests for pain to the injured extremity.
- C There will be significant statistical differences in the pre-tests and post-tests for femoris muscles' strength to the injured extremity.
- C There will be significant statistical differences in the pre-tests and post-tests for the range of motion to the injured extremity.

#### **MATERIALS AND METHODS**

A sample of five female patients, ranging in age from 55 to 65 years (x =60years), who had recently undergone hip replacement surgery were independently assigned to a physical rehabilitation program and electro-stimulation sessions, group (n = 5). All patients were familiarized with the study and gave their informed consent before admission to the study.

Patients were treated five times a week for 3months. The physical rehabilitation program consisted of 3 phases, the pretest measurements were done on Thursday 8 -4-2010, the post-test measurement was done for every subject after 12 weeks.

**Phase 1:** An exercise program lasted 4 week for 5sessions a week, in the beginning of every session subjects warmed up with 10 minutes of gait training (alternating forward and backward walking) and 5 minutes of passive stretching, this phase aimed to decrease pain, maintain range of motion, muscular strength and cardiovascular endurance.

**Phase 2:** A compound of physical rehabilitation (4 weeks, 5 times a week) and 10 electrical stimulation sessions (3 sessions a week) of the quadriceps femoris and hamstring muscles. There were four gelled electrodes connected to the same circuit of the muscle stimulator, placed over the patient's quadriceps and hamstring muscles. The electrodes were taped to the patient's skin and the current carrier wave was 50 Hz per second. This current affected the muscle to maximal contraction for 10 seconds and full relaxation for 10 seconds duration was 5 minutes this phase aimed to decrease pain, restore range of motion, muscular strength and cardiovascular endurance.

**Phase 3:** Decreasing pain, developing muscular strength and cardiovascular endurance by restoring full ROM in the affected extremity using progressive resisted exercise.

#### **Tests:**

**A Visual Analogue Scale (VAS):** It is a measurement instrument that tries to measure a characteristic or attitude that is believed to range across a continuum of values and cannot easily be directly measured. For example, the amount of pain that a patient feels ranges across a continuum from none to an extreme amount of pain From the patient's perspective this spectrum appears

continuous  $\pm$  their pain does not take discrete jumps, as a categorization of none, mild, moderate and severe would suggest. It was to capture this idea of an underlying continuum that the VAS was devised. Operationally a VAS is usually a horizontal line, 100 mm in length, anchored by word descriptors at each end, the patient's marks are signed on the line and the point means that what she feels represents her perception of her current state. The VAS score is determined by measuring in millimeters from the left hand end of the line to the point that the patient marks [6], we did this measurement initially to every session.

**Range of Motion (ROM):** It is defined as the joint flexibility allowed at a joint. A joint's ROM is usually measured by the number of degrees from the starting position of a segment to its position at the end of its full range of the movement. The most common way this is done is by using a double-armed goniometer. A stationary arm holding a protractor is placed parallel with a stationary body segment and a movable arm moves along a moveable body segment. The pin (axis of goniometer) is

placed over the joint. When anatomical landmarks are well defined, the accuracy of measurement is greater, the hip joint should allow for the upper leg to flex upwards (bringing the thigh closer to the abdomen) to 110 to 130 degrees and extend backwards behind the body to 30 degrees. Normal hip range also allows for abduction (moving the leg out away from the body, to the side) to 45 degrees and adduction (moving the leg inwards and across the other leg) to 20 to 40 degrees. This measurement was done 2 times, one measurement initially to the physical rehabilitation program and the second measurement on the 12 week [7].

**Hip Muscles Strength Test -Flexion:** Dynamometer is used to assess hip flexion strength; the subject lies on her back. The leg is bent at the knee and the subject attempts to touch her knee to her chest while keeping the hip from coming up and off from the table. The dynamometer is placed on top of the knee. The dynamometer applies resistance as the subject attempts to raise her leg. The dynamometer measures the resistance and provides an objective reading of the force applied [7].

Table 1: Physical rehabilitation protocol (flexibility, strengthening and endurance exercises)

Phase 1: 4 weeks, 5 sessions a week: 25-35 minutes aimed to decreased pain, maintain range of motion, muscular strength and cardiovascular endurance.	
1.	Lower extremity isometric contraction: Tighten the operated leg muscles, hold until feel pain, 10 repetitions.
2.	Quadriceps isometric setting: Tighten the thigh muscle and then straighten the knee. Hold until feel pain, Repetition 10 times, rest 10seconds.
3.	Gluteal Setting: lying on the back with legs straight and in contact with the bed. then tighten the buttocks in a pinching manner and hold the isometric contraction, until feel pain, repetitions 10 times
4.	Ankle Pumps: Slowly pushing foot up and down. 10 repetitions.
5.	Ankle Rotations: Moving the ankle inward toward one foot and then outward away from, the other foot: 5 repetitions each direction, 4 sets.
6.	Supported Knee Bends: Sliding the heel toward the buttocks, bending the knee and keeping heel on the bed. 10 repetitions, or until feel pain, 5 sets.
7.	Abduction knee Exercise: bending knees, moving out to the side and back, 10 repetitions, 4sets or until feel pain.
8.	Straight Leg Raises: Tighten the thigh muscle with the knee fully straightened on the bed. As the thigh muscle tightens, lifting the leg several inches off the bed hold until feel pain. Slowly lower.
Phase 2: 4 weeks, 5 sessions a week: 35-45 minutes phase aimed to decreased pain, restore range of motion, muscular strength and cardiovascular endurance.	
*Muscle stimulation: Electrical muscle stimulation to quadriceps & hamstring muscles, 3sessions a week, 10 minutes, rest 50 seconds, 10 contractions.	
* The previous exercise.	
9.	Active and passive knee flexion: bend knee until 90 degrees gradually with assistant, until feel pain.
10.	Standing Knee Raises: standing hold a wall bar, lifting the non-operated leg toward the waist. Hold for 2 or 3Counts and put the leg down.
11.	Standing Knee Raises: standing hold a wall bar, lifting the operated leg toward the waist. Hold for 2 or 3Counts or until feel pain and put the leg down.
12.	Standing Hip Abduction: lifting the leg out to the side. Slowly lower the leg so the foot is back on the floor. 10 repetitions or until feel pain.
13.	Standing Hip Extensions: Lifting the operated leg backward slowly.
Hold until feel pain. Return the foot to the floor.	
14.	Walking with Walker, Full Weight bearing: Moving the walker forward a short distance. Then move forward, lifting the operated leg so that the heel of the foot will touch the floor first. And the entire foot will rest evenly on the floor. Complete the step, allow the toe to lift off the floor. Move the walker again and the knee and hip will again reach forward for the next step.
14.	Gait training without brace, alternating forward and backward ambulation: 10 min.
Phase 3: 4 weeks, 5 sessions a week: 45-55 minutes decrease pain, develop muscular strength and cardiovascular endurance by restore full ROM in the injured extremity.	
*The previous exercise:	
15.	Stationary cycling: 10 minutes.
16.	Side step-ups, front step-ups, step-downs: beginning with 3 sets of 10 repetitions, Progressing to 3 sets of 15 repetitions, heights ranging 10to21cm, "up with the good" and "down with the bad."
17.	Hip flexion, extension, abduction, adduction in standing: using a wall pulley with 4.54-kg (10-lb) plates: beginning with 3 sets of 10 repetitions, progressing to 3 sets of 15 repetitions.
18.	Knee flexion in sitting: 3 sets of 10 repetitions; boot: beginning with 3 sets of 10 repetitions, progressing to 3 sets of 15 repetitions.

**Hip Muscles Strength Test -Extension:** A Dynamometer is used to assess hip extension strength. The subject lies on her stomach. The leg is bent at the knee and the subject attempts to touch her heel to her back while allowing the hip to come up from the table. The dynamometer is placed on backside of the leg, generally at the hamstring. The dynamometer applies resistance as the subject attempts to raise her leg. The dynamometer measures the resistance and provides an objective reading of the force applied [7].

**Minutes Walk Test:** It is a measurement of activity limitation and walking long distances.

**Description:** A physical performance measure which assesses how far a person can walk in 6 minutes. During the performance of the 6 minute walk test (6MWT), patients are instructed to cover as much distance as possible during the 6- minute time frame with the opportunity to stop and rest if required. The test is conducted on an unobstructed level surface. The course is marked off in meters and the distance traveled by each subject is measured to the nearest meter. Standardized verbal encouragement, "you are doing well, keep up the good work" is provided at 60-second intervals. Patients are permitted to use their regular walking aids if needed [8].

**Stair Measure:** It is a measurement of activity limitation and climbing.

**Description:** A physical performance measure, which assesses how well a person, can ascend and descend a flight of stairs. During the performance of the stair measure (SM) patients are instructed to ascend and descend 9 steps (step height, 20 cm) in their usual manner and at a safe and comfortable pace [9].

**EMG test (Electromyography); DANTEC Key and Point2 Channel:** They are to assess the electrical activity of hip muscles. A needle is inserted through the skin into the muscle. The electrical activity is detected by this needle (which serves as an electrode). The activity is displayed visually on an oscilloscope [10].

**Data Management and Analysis:** The target was the differences in measurements which calculated and used to compare the values between variables (pain, ROM, muscles strength, EMG) prior to the physical rehabilitation program and 12 weeks following.

## RESULTS AND DISCUSION

Values for the amount of pain that a patient feels are described in Table 2. The hip joint flexibility values (ROM) are described in Table 3, the mean percentage of both extension and flexion torque ratios on the involved side of patients were significantly different than the pre values Table 4, the variations between the pre-test of electrical activity of hip muscles (quadriceps and hamstring) and the last test are described in Table 5.

Table 2 indicates the statistical differences between the pre-tests and post-tests for the subjects (n=5) in pain and these differences are valid to the post-tests, T value in 0.05= 2.32.

Table 2: Differences between the pre-tests and post-tests for the subjects in pain variable (hip VAS) (N= 5)

Variable	Pre-tests		Post-tests		SDF		
	M	SD	M	SD	MF	SD	T
Pain	5.81	1.11	0.29	0.101	1.11	5.81	19.15

Table 3: Improvement percentage for the pre-test and post-test differences for the subjects in pain reduction (N=5)

Pre-test	Post-test	Percentage
5.81	0.29	95%

Table 4: Differences in muscle strength (Nm) (mean ± SD) within the hip OA group (N= 5)

Hip Functions	None injured Hip.	Injured Hip	Ratio (%) Between Sides
Isometric Adduction	120±22	116±31	95
Isometric Abduction	107±20	107±28	100
Flexion Isometric	106±21	84±24	79*
Isokinetic Peak torque 60°/s	121±22	104±30	86*
120°/s	112±26	91±33	83*
Extension Isometric	86±22	65±20	78**
Isokinetic Pea Torque 60°/s	178±46	156±52	87*
120°/s	161±46	136±60	86*

The ratio between the non-injured hip and the injured hip (RSD) grading was \*p < 0.05, \*\* p < 0.01, paired t test

Table 5: Range of motion of the non injured hip and injured hip (n = 5)

Hip Functions	Non injured hip	Injured Hip	P value*
Flexion	122°±16.3°(103°-145°)	125.4°±9.7°(104°-143°)	< 0.001
Extension	56.5°±20.1°(12°-101°)	71.1°±26.4°(16°-125°)	0.051
Adduction	63.3°±10.9°(40°-85°)	63.6°±7.5°(50°-76°)	0.001
Abduction	32.7°±12.3°(4°-52°)	35.8°±15.3°(17°-63°)	0.262
Internal rotation in 90° flexion	35.2°±6.9°(11°-61°)	35.8°±15.3°(17°-63°)	0.002
External rotation in 90° flexion	102.5°±14.2°(75°-131°)	93.9°±32.7°(27°-13°)	0.327

\*Difference between non injured hip and injured hip

Table 6: Summary of differences in EMG-measurement changes (N = 5)

	Pre-test		Post -test	
	Mean	STD.	Mean	STD.
Time of Measurement (sec.)				
2-4	2.32	0.8	2.20	0.65
4-6	2.38	0.63	2.30	0.60
6-8	2.39	0.62	2.26	0.61

Measure was scaled by division by 100 and squared due to a left- skewed distribution

Table 7: The values of six minute walk test distance and stair measure measurements in the Pre-test and Post-test

Measure	Pre-test Mean, SD Quartiles n = 5	Post-test Mean, SD, n Quartiles n=5
Six minute Walk Test Distance (meters)	411, 113 310, 402, 518	418, 115, 81 318, 408, 527
Stair Measure (seconds)	16.1, 9.2 12, 14, 21	21.0, 9.6, 81 11, 17, 26

Mean and quartile scores of the performance measures for six minute walk test (meters) and stair measure (seconds)

Table 3 indicates that the percentage for the pre-test and post-test differences for the subjects in pain reduction = 95.

Table 4 shows significant differences between the pre-test and post-test for muscle strength variables measurements.

Table 6 shows significant differences between the post- test measurements of the EMG and the pre-test measurements for the injured hip.

## DISCUSSION

Table 2 shows statistical significant differences between the pre-tests and post-tests for the subjects in pain variable and Table 3 shows the improvement percentage for the pre-test and post-test differences for the subjects in pain reduction ( 95%) and this is due to the effect of the physical rehabilitation program and the electro stimulation in pain reduction for the injured extremity, This finding contrasts with those of previous studies conducted in individuals had gone under reconstruction for hip or knee joint [11, 12]. Also MacDonald *et al.* [13] published a case series describing the outcomes of individual patients with hip OA treated

with manual physical therapy and exercise. Patients exhibited reductions in pain and increases in passive ROM, as well as a clinically meaningful improvement in function and this achieved the first purpose.

Table 4 shows statistical significant differences between the pre-tests and post-tests for the subjects in muscle strength variable in isometric and isokinetic adduction, abduction and flexion peak torque and this achieved the second purpose and contrasted with Van Baar *et al.* [14]. Table 5 shows the progression in range of motion for the injured hip in comparing with the pre-test initially of the physical rehabilitation and electro stimulation and the post-test in the essential functions for the hip joint (flexion, extension, adduction, abduction, internal rotation in 90° flexion, external rotation in 90° flexion) and this achieved the third purpose, range of motion and strengthening exercises have been advocated by many authors as a component of the management for patients with OA of the hip showing that exercise is effective in patients with OA of the hip using an exercise program previously [4, 15-18].

In addition to these studies' results, the electromyography for femoris muscles indicates a useful feedback to the subjects about the intensity of muscle

electric activity as described in Table 6 and this also confirm the effectiveness of physical rehabilitation program and electro stimulation.

As reported by Oostendorp *et al.* [19] that exercise is effective with patients with OA of the hip that consisted of flexibility, hip muscle strengthening and an aerobic exercise. Van Baar *et al.* [14] reported that the beneficial effects of reduced pain are less use of medication, improved function declined and losing any earlier gain that were made and this explain why the physical rehabilitation and electro stimulation program lasted 12 week.

The optimal value of the research findings is the enhancement of the essential daily living functions as described in Table 7 as shows the measurement of activity limitation and walking long distances (6 minutes walk) which assesses how far a person can walk in 6 minutes and the measurement of activity limitation and climbing, which assesses how well a person, can ascend and descend a flight of stairs.

## CONCLUSION

### The Results of this Study Suggest That:

- C The physical rehabilitation program combined with electro stimulation for patients after hip joint replacement surgery is effective in reducing pain. The improvement percentage for the pre-test and post-test differences for the subjects in pain reduction was 95%.
- C The physical rehabilitation program combined with electro stimulation for patients after hip joint replacement surgery is effective in the progression in femoris muscles strength.
- C The physical rehabilitation program combined with electro stimulation for patients after hip joint replacement surgery is effective in restoring hip ROM.
- C The physical rehabilitation program combined with electro stimulation for patients after hip joint replacement surgery is effective in enhancing the essential daily living activates like walking and climbing stairs.

### Recommendations:

- C Using the physical rehabilitation and electro stimulation program as an optimal intervention to patients' pain reduction after underwent hip joint reconstruction.

- C Using the physical rehabilitation and electro stimulation program as an optimal intervention to restore femoris muscle strength and hip ROM after hip joint reconstruction.
- C Using the physical rehabilitation and electro stimulation program as an optimal intervention to patients' to restore the quality of live.
- C Similar studies need to be undertaken by utilizing alternative interventions.
- C Further studies need to be undertaken for using physical rehabilitation and electro stimulation to rehabilitate from different trauma.

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