



To compare the effectiveness of Neuromuscular electrical stimulation and Electromyography biofeedback in individuals following Total Hip arthroplasty

Authors

Dr Krupa M. Soni¹, Dr Reji.K. Samuel²

¹Assistant Professor, Nootan College of Physiotherapy, Sankalchand Patel University, Visnagar-384315.Gujarat

²Principal, C.U. Shah Physiotherapy College, Medical College Campus, Dudhrej Road, Surendranagar-363001, Gujarat

Abstract

Background: *The most common complication after Total Hip Arthroplasty is reflex inhibition of quadriceps muscle leading to reduced function. The aim of the study was to compare the effectiveness of NMES and EMG biofeedback along with Conventional exercise program and Conventional exercise program alone in the recovery of Quadriceps muscle strength and hip function in the early phases of rehabilitation following total hip arthroplasty.*

Methods: *In a 4-week intervention study, 36 patients following total hip arthroplasty were studied. They were divided into three groups by convenience sampling, Group A: (n=12) Conventional exercise program, Group B: (n=12) NMES along with Conventional exercise program and Group C: (n=12) EMG biofeedback along with Conventional exercise program was applied. For all 3 groups, treatment consisted of 1 session/day, 5 days/week for 4 weeks. Data was collected and analyzed using SPSS16.0.*

Results: *A significant improvement in the strength of quadriceps muscle ($p < 0.05$), and increase in hip function ($p < 0.05$) between pre & post treatment stages in all three groups with no statistically significant ($p > 0.00$) difference between NMES group and EMG biofeedback group were found.*

Conclusion: *In the experimental conditions used in this study, the use of NMES along with Conventional exercise program and EMG biofeedback along with Conventional exercise program was effective when compared to Conventional exercise program alone; NMES and EMG biofeedback was equally effective in the early phases of rehabilitation following Total hip arthroplasty.*

Keywords: *Total Hip Arthroplasty, Quadriceps Muscle Strength, Harris Hip Score, NMES, EMG Biofeedback.*

Introduction

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.¹ It is a highly cost-

effective procedure.² Total hip replacement (THR) is a well-accepted surgical procedure for patients with advanced arthritic disorders at the hip.³ The most common preoperative complaints by patients who elect to have THR are pain and loss of mobility.⁴ Total hip arthroplasty, is implanting an

artificial femoral head and socket to replace the hip joint to relieve pain while preserving motion and stability.⁵ Postero-lateral approach popularized by Moore is the most frequently used approach for primary THA. Cement fixation is routinely used for patients with osteoporosis and poor bone stock and typically with elderly patients.⁶ A large group of patients who undergo THA have mild to moderate long-term impairments post operatively. The impairments include reduced walking efficiency & speed, pain, weakness of the hip muscles, contracture of the hip, gait disorders.⁷

Strength of the thigh muscles has been shown to be an important predictor of walking speed and functional performance in patients with THR.³ Poor muscle performance was correlated with poor function indicating that appropriate and targeted strengthening exercises to the muscles controlling the knee and hip joints on the operated side may be required to achieve maximum functional outcome.⁸ With marked muscle atrophy and loss of muscle strength of the ipsilateral quadriceps muscle and with the quadriceps muscle playing a major role in preserving walking & function autonomy in the elderly following THA,⁹ various researchers have investigated the effect of addition of Neuromuscular electrical stimulation, & EMG biofeedback along with Conventional exercise program for quadriceps muscle strengthening after THA.^{1, 10, 11, 12, 13}

Need and Significance of the Study

Total hip arthroplasty (THA) is among the most widely performed procedures in orthopedic practice and with aging of the population, the number of person who require THA is on the rise.¹⁴ The quadriceps has a major role in preserving walking & function autonomy in the elderly following THA.¹⁰ Though various researchers have investigated the effect of addition of Neuromuscular electrical stimulation, & EMG biofeedback in isolation along with the Conventional exercise program for muscle

strengthening after THA, comparison of the two have been seldom investigated.

The need for the study is to find the effectiveness of NMES and EMG biofeedback along with Conventional exercise program in individuals following total hip arthroplasty in the local population, to determine the better of the two so that the same intervention program could be followed in clinical practice and thereby greater benefits could be obtained by patients.

Aim of the Study

The Aim of the study was to compare the effectiveness of NMES and EMG biofeedback along with Conventional exercise program in the recovery of quadriceps muscle strength and hip function in individuals following total hip arthroplasty.

Objectives of the Study

1. To determine the effectiveness of NMES & EMG biofeedback along with Conventional exercise program in the recovery of quadriceps muscle strength and hip function in individuals following total hip arthroplasty.
2. To find out whether there is any significant difference between the effectiveness of NMES & EMG biofeedback along with Conventional exercise program in the recovery of quadriceps muscle strength and hip function in individuals following total hip arthroplasty.

Materials and Methodology

Research Design: Experimental design

Sample Design: Convenience sampling (Random allocation-lottery method–without replacement)

Study Population: Post total hip arthroplasty subjects

Study Setting: Physiotherapy OPD of C.U. Shah Physiotherapy College.

Sample Size: 36 subjects

Group A: 12 subjects, (Control group)

Group B: 12 subjects, (NMES group)

Group C: 12 subjects (EMG Biofeedback group).

Study Duration: 1 year

Treatment Duration: 4 weeks

Selection Criteria

Inclusion Criteria

1. Age: 60-75 years of age.¹⁵
2. Subjects who have undergone Unilateral Total hip arthroplasty.¹⁰
3. Subjects operated with posterolateral approach for hip arthroplasty.
4. Subjects with cemented total hip arthroplasty.
5. Subjects willing to take part in the study by signing a written informed consent.
6. Repair of Posterior capsule, piriformis, and short external rotator muscle.

Exclusion Criteria

1. Subjects who come 48 hours after surgery.
2. Subjects with lateral and antero-lateral approach.
3. Neurologic gait disorders, neuromuscular disease.¹⁶
4. Hemiplegic, Parkinson's disease, Dementia or decreased cognitive status that would affect ability to follow simple instructions.^{13,16}
5. Cardiopulmonary contraindications for exercise training.¹⁷
6. Subjects who are having sciatic nerve injury following THA.
7. Dermatological conditions (e.g. eczema, dermatitis).¹⁷
8. Allergy to the electrode or contact material (tape / gel).¹⁷
9. Subjects with insufficient audition and reception to hear and comprehend simple directions or are unable to respond to the instructions of the therapist.¹⁷
10. Subjects with Impaired sensations.¹⁷

Outcome Measures

1. Strength of Quadriceps muscle
2. Functional hip score (Harris Hip score)

Data Collection Procedure

All the subjects completed a detailed Orthopaedic assessment.

Subjects who fulfilled the selection criteria were informed about the study and requested to sign written informed consent forms. Experiments were conducted on 12 subjects in Group A, 12 subjects in Group B and 12 subjects in group C. Each subject was evaluated prior to the first session, and after the last session, concerning the following aspects:

Muscle Strength

Isometric quadriceps strength was measured bilaterally, using a Baseline hydraulic hand-held dynamometer. Subjects sat upright on the examination table with the hips flexed at 90 degrees and knees flexed at approximately 60 degrees.

The subjects were asked to build force to a maximum over a 2-second period and maintain the maximum effort for approximately 5 seconds. The subjects were then requested to stop.

The subjects were made to perform the test three times, and the best of it was recorded. A pause of 10-20 seconds was provided between each trial.^{18,19}



Figure-1 Quadriceps muscle strength measurement

Harris Hip Score

The HHS score gives a maximum of 100 points.

- Pain - 44 points,
- Function - 47 points,
- Range of motion- 5 points,
- Deformity- 4 points

Score Interpretation

The higher the Harris hip score, lesser the dysfunction.

A total score of

<70 considered poor result;

70–80 considered fair,

80–90 considered good, and

90–100 considered an excellent result.²⁰

Treatment Protocol

The subjects were divided into three groups,

Group A was given Conventional exercise program

Group B was given NMES+ Conventional exercise program

Group C was given EMG biofeedback+ Conventional exercise program

Table-1 Treatment Protocol for Control group, NMES group and EMG Biofeedback group

Week ¹	Weight bearing ⁶	Advice ^{6,23}	Group A (control group) ^{1,6,23}	Group B (NMES Group) ^{1,6,17,23}	Group C (EMG biofeedback) ^{1,6,17,23}
1-4 weeks Maximum Protection Phase 5 sessions per week	As tolerated by patient. Ambulation with an assistive device (walker or two crutches)	-Limit flexion of the hip to <90° rotation to <45° -Avoid pillow under the knee, avoid side lying & driving in car - Use abduction pillow	<u>Supine lying:</u> -Quadriceps isometric setting (10 rep× 10 sec hold, 2sets/day) -Straight leg raise (5 rep×2 sets/ day) -Gluteal setting (10 rep× 2 sets/day), - Hip abductor setting exercises (10 rep× 2 sets/ day). -Ankle pumps (10 rep× 2sets/day), -Ankle rotations (5 rep in each directions, 4 sets/day), - Active assisted ROM exercises of hip within protected range (10 rep× 2 sets/ day). <u>Prone-lying:</u> -Hip extension exercises. (10 rep×1 set/day), <u>Standing:</u> -Active hip ROM exercises. (10 rep×2 sets / day)	<u>Supine lying:</u> NMES: -Type of stimulator: constant voltage -Waveform: Symmetrical biphasic -Frequency: 50 pulse per second -Intensity: Maximum Tolerated Level -Duty cycle: 10 seconds on/10 seconds off -Ramp: 2 second -Phase duration: 200 microseconds -Treatment time: 15 minutes -Quadriceps isometric setting (10 rep×10 sec hold, 2sets/day) -Straight leg raise (5 rep×2 sets/ day), -Gluteal setting (10 rep×2sets /day), - Hip abductor setting exercises (10 rep× 2 sets/ day). -Ankle pumps (10 rep×2sets / day), -Ankle rotations (5 rep in each directions, 4 sets/day), -Active assisted ROM exercises of hip within protected range (10 rep×2sets/day). <u>Prone-lying:</u> -Hip extension exercises(10 rep×1 set/ day), <u>Standing:</u> -Active hip ROM exercises.(10 rep×2 sets / day)	<u>Supine lying:</u> EMG biofeedback: - Contraction of the quadriceps muscle to their EMG threshold level, maintain the audible signal for 10 seconds on, and to rest for 10 seconds off. -Quadriceps isometric setting (10 rep×10 sec hold, 2sets/day) -Straight leg raise (5 rep×2 sets/ day), -Gluteal setting (10 rep× 2sets/ day), - Hip abductor setting exercises (10 rep× 2 sets/ day). -Ankle pumps (10 rep×2sets/ day), -Ankle rotations (5 rep in each directions, 4 sets/day), -Active assisted ROM exercises of hip within protected range (10 rep× 2 sets/ day). <u>Prone-lying:</u> -Hip extension exercises(10 rep ×1 set / day), <u>Standing:</u> - Active hip ROM exercises (10 rep×2 sets/day)



Figure -2 NMES & EMG biofeedback Unit



Figure -3 NMES along with SLR



Figure 4- EMG Biofeedback along with static quadriceps exercise

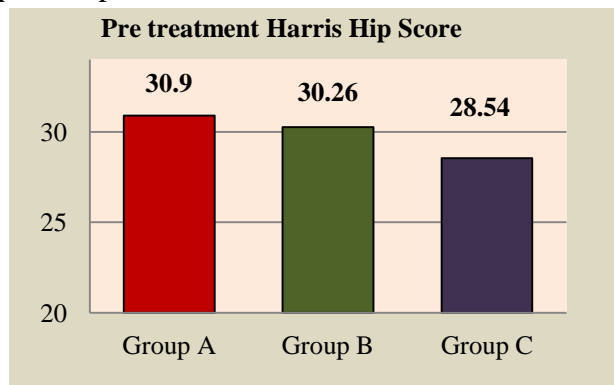


Figure-5 Intergroup comparison of pre treatment Harris hip score

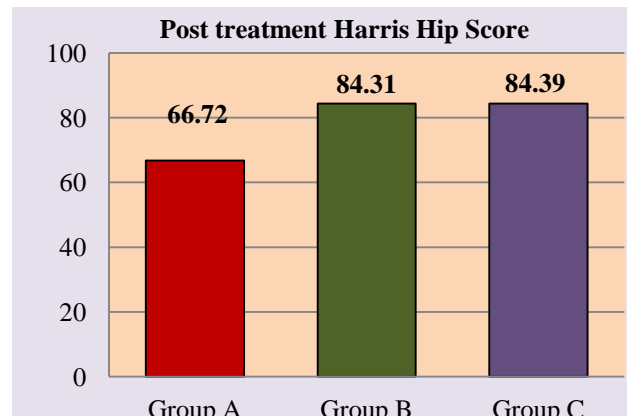


Figure- 6 Intergroup comparison of post treatment Harris hip score

Statistical Analysis & Results

- All statistical analysis was done using SPSS 16.0 software for windows.
- Descriptive analysis was obtained by mean & standard deviation.

Intergroup comparison of pre treatment scores of Quadriceps muscle strength & Harris Hip Score was done using one way ANOVA non parametric Kruskal Wallis Test, respectively.

Table 2: Intergroup Comparison of Quadriceps muscle strength before & after treatment

Quadriceps muscle strength (Kg)	Group A (Mean±SD)	Group B (Mean±SD)	Group C (Mean±SD)	F value	p value
Pre treatment	1.95±0.81	2.0±0.95	1.5±0.90	1.16	0.325
Post Treatment	8.16±0.71	14.08±1.37	14.00±2.00	64.55	0.00

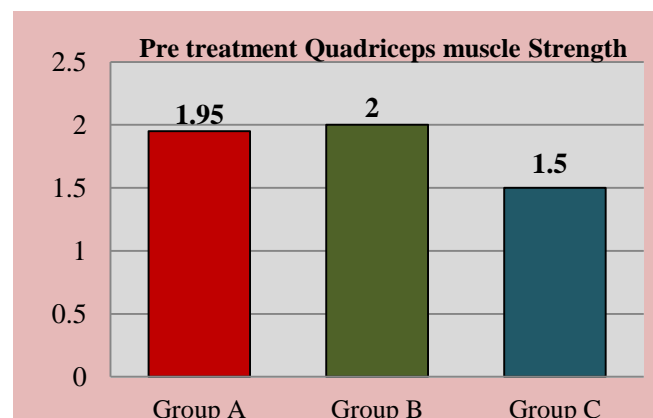


Figure- 7 Inter group comparison of pre treatment Quadriceps muscle strength

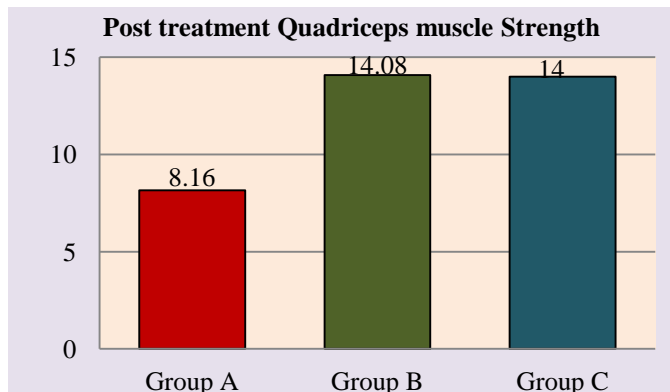


Figure-8 Intergroup comparison of Post treatment Quadriceps muscle strength

Table 3: Intergroup Comparison of Harris Hip Score before & after treatment

Harris Hip Score	Group A (Mean±SD)	Group B (Mean±SD)	Group C (Mean±SD)	p value
Pre treatment	30.90±9.06	30.26±7.09	28.54±7.99	0.778
Post Treatment	66.72±6.02	84.32±3.74	84.39±2.70	0.00

Intragroup comparison of pre & post treatment scores of Quadriceps muscle strength & Harris Hip Score was done using parametric Paired t-test, and non parametric wilcoxon Signed Rank Test, respectively, where the p value is <0.05.

A statistically significant difference was found between pre & Post treatment quadriceps muscle strength & Harris Hip Score.

A statistically significant difference was found between Group A vs Group B (p<0.05) & Group A vs Group C (p<0.05).

No statistically significant difference was found between Group B and Group C.

Table: 4 Multiple Comparison for mean of difference of Quadriceps muscle strength between Groups A, B and C (alpha 0.05) after 4 weeks of the study

N=36	Quadriceps muscle strength		
	MD	SE	P value
A vs B	5.91	0.59	0.00
A vs C	5.83	0.59	0.00
B vs C	0.08	0.59	0.989

Table 5: Comparison for mean of difference of Harris hip score between Groups A, B and C (alpha 0.05) after 4 weeks of the study

N=36	Harris Hip Score	
	Z value	P value
A vs B	-4.16	0.00
A vs C	-4.16	0.00
B vs C	-0.98	0.989

One way ANOVA post hoc analysis was done to compare the difference in effectiveness within the groups for quadriceps strength.

Mann-Whitney U Test of post treatment scores of Harris hip score was done to compare the difference in effectiveness within groups.

Discussion

Positive results concerning improvements in the strength of the Quadriceps muscle may be solely explained by the immediate post operative rehabilitation. An isometric contraction provides stabilization strength that helps maintain normal length-tension and force-couple relationships, which are critical for normal joint arthrokinematics.²¹ Isometric exercises are capable of increasing muscular strength.²² Electrical stimulation is thought to strengthen muscles by two mechanisms: 1) overload and 2) specificity.¹⁷ The strength gains with EMG biofeedback in Group C may have occurred based on two components as suggested by Delorme and Watkins; 1) the neural changes associated with heightened motor unit activation and more organized patterns of activation, collectively referred to as "motor learning," and 2) the actual morphological changes that result in hypertrophy.¹¹ Further studies can be taken up with different intervention parameters for improving Quadriceps muscle strength and Harris hip score in the early phases of rehabilitation following Total hip arthroplasty. Further studies can be taken up using the same intervention procedures for improving Quadriceps muscle strength and Harris hip score in the early phases of rehabilitation following other hip surgeries like hemiarthroplasty of hip, surface replacement

arthroplasty. The limitation of the study is that the long term follow up has not been taken.

Conclusion

In the experimental conditions used in this study, all three groups showed significant improvement in quadriceps muscle strength and hip function. The use of NMES along with Conventional exercise program (Group B) and EMG biofeedback along with the Conventional exercise program (Group C) evidenced a significantly greater improvement in isometric quadriceps muscle strength and Harris hip score when compared to conventional exercise program alone (Group A), with no statistically significant difference between the two experimental groups (Group B and group C) in the early phases of rehabilitation following Total hip arthroplasty.

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