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Effectiveness Of Rehabilitation Exercise Program Along With Neuromuscular Electrical Stimulation (Nmes) On Patients Who Have Undergone Total Knee Arthroplasty In Terms Of Knee Pain, Knee Rom, Quadriceps Strength And Functional Outcomes-A Quasi Experimental Study

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ABSTRACT
Background: *-Total Knee Replacement (TKR) or Total Knee Arthroplasty (TKA) is a common orthopaedic surgery that involve replacing the articular surfaces of the knee joint with smooth metal and highly cross-linked polyethylene plastic. Physical Impairments occur after TKA Surgery and all these impairments contribute to inability to do Activities of Daily Living and hence effect quality of life. As a result of these impairments, we aim to evaluate the effectiveness of Rehabilitation Exercise Program along with Neuromuscular Electrical Stimulation (NMES) to see its role on TKA Patients.*
Methods: *- 40 patients aged between 50-75 years, both genders, who have undergone TKA with history of Osteoarthritis were selected for the study. The patients were divided into two groups based on Convenient Sampling i.e. Group A(n=20) and Group B(n=20). The patients were assessed on post-operative day 1 for Knee pain with Numerical Pain Rating Scale (NPRS), Knee Range of Motion (ROM) with Universal Goniometer, Quadriceps Strength with Manual Muscle Testing (MMT) and Functional Outcomes with Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) and Timed up and Go Test (TUG). Group A received Rehabilitation Exercise Program along with NMES and Conventional Physiotherapy and Group B received Conventional Physiotherapy alone for 8 weeks and were reassessed at 4th and 8th week.*
Results: *The result showed that there was significant improvement in NPRS, Quadriceps Strength, Knee ROM and Functional Outcomes in Group A and B. But Group A shows significant improvement ($p<0.05$) as compared to Group B.*
Conclusion: *The study findings concluded the positive outcomes of Rehabilitation Exercise program along with NMES and Conventional Physiotherapy compared to Conventional Physiotherapy alone.*
Keywords: *Conventional Physiotherapy, Rehabilitation Exercise Program, TKA.*

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I. Introduction

Total Knee Arthroplasty (TKA), also known as Total Knee Replacement (TKR), is one of the most commonly performed orthopaedics procedure. About 70,000 joint replacement surgeries were performed in 2011 in India with expected growth rate of 26.7% till 2017. TKA due to Osteoarthritis is the commonest with 93.98%.[1] Surgical Intervention, such as Knee Arthroplasty, can be used in those with end stage Knee OA.[2]

In early post-operative phase, it causes a severe localised inflammatory response in the soft tissues of the knee, with local haemorrhage and hematoma formation, which reaches its peak in the first few hours after surgery. Pain, swelling and surgical damage to knee joint reduces excitatory input to muscles surrounding the affected joint. Motor cortical mechanisms causing quadriceps Central Activation deficit following TKA, resulting in more severe muscle weakness than prior to surgery. Also, quadriceps muscle atrophy increases post-surgery which further leads to quadriceps weakness.[1]

Quadriceps muscle weakness has been associated with decreased gait speed, balance, stair-climbing ability, and ability to rise from a seated position, as well as with an increased risk for falls.[3] Functional performance is reported to worsen by 20-25% 1 month after TKA[4].

One post-operative modality that can help improve regaining strength of this muscle is Neuromuscular Electrical Stimulation (NMES). NMES is a neuro-modulatory technique that strengthens muscles through the increased recruitment of type II muscles fibres.[5]

Physiotherapy post TKA aims at decreasing pain and swelling, increasing range of motion, muscle strength and thus, improving mobility.[1] National Institutes of Health-sponsored consensus development conference on TKA concluded that "the use of rehabilitation services is one of the most understudied aspects of the perioperative management of patients following Arthroplasty" and "there is no evidence supporting the generalized use of any specific preoperative or postoperative rehabilitation interventions.[4]

In order to achieve greater effectiveness for longer duration, Rehabilitation Exercise Program is combined with NMES. Thus, the purpose of the present study is to treat TKA Patients with Rehabilitation Exercise Program along with early addition of NMES after TKA to see its effect on quadriceps muscle strength, Knee Pain, Knee ROM and functional performance for enhancement in improved mobility which is considered to be important for obtaining maximum benefit Post TKA.

II. Material and Methods:

Study Design: Quasi-experimental.

Study Location: This study was done in Out Patient Department of University College of Physiotherapy, Faridkot and Out Patient Department, Department of Orthopaedics, Guru Gobind Singh Medical College and Hospital, Faridkot.

Study duration: September 2022 to March 2023

Sample Size: 40 patients

Subjects and Selection Method: The study population was drawn from Guru Gobind Singh Medical College and Hospital. Eligible Patients were assigned to either Experimental Group (Group A) (n=20) and Control Group (Group B) (n=20) based on Convenient Sampling.

Inclusion Criteria:

1. Post TKA Patients with history of Osteoarthritis
2. Aged between 50-75 years
3. Both males and females
4. Patients who have undergone unilateral, Tricompartmental, cemented TKA with a medial parapatellar surgical approach.
5. TKA Patients in acute setting i.e. at postoperative day 1
6. Patients who are able to follow the instructions.

Exclusion criteria

1. Revision TKA
2. Patients with Neurological Conditions
3. Uncontrolled Hypertension
4. Uncontrolled Diabetes
5. Osteoporotic Patients
6. Patients with Visual and Auditory deficits
7. Uncooperative Patients
8. Bilateral TKA Patients
9. Patients with Psychiatric and Cognitive Disorder
10. Patients with any Carcinoma
11. Patients with any Fracture
12. Patients with any Infective condition of Knee
13. Patients with Bleeding Diathesis
14. Post-Traumatic TKA
15. Patient with impaired sensation
16. Patients with contralateral Knee Pain.

Procedure Methodology: After written informed consent was obtained. After that the patients were divided into two groups based on Convenient Sampling i.e. Group A (N= 20) and Group B (N=20). Patients were assessed on postoperative day 1 for knee pain with Numerical Pain Rating Scale (NPRS), Knee Range of Motion (ROM) with

Universal Goniometer, Quadriceps Strength with Manual Muscle Testing (MMT) and Functional Outcomes with Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) and Timed up and Go Test (TUG). Physiotherapy to Group A was given as per the guidelines of Mintken[6] et al TKA Protocol along with NMES and Conventional Physiotherapy. Group B received Conventional Physiotherapy alone.[7]

Group A received Inpatient rehabilitation Exercise program for week 1. Then Home Health Rehabilitation Exercise program from week 2 to week 3 which included Range of Motion Exercises, Strengthening Exercises, Functional Activities Training, Incision Mobility. Outpatient Rehabilitation Exercise program began from week 4^{th} to week 8^{th} which included Progression of Range of Motion Exercises, Strengthening Exercises, Functional activity training. Along with these exercises NMES Treatment began from Postoperative day 1 up to week 6 and Conventional Physiotherapy exercises were also included. Group B received Conventional Physiotherapy alone 5sessions/week for 8 weeks.

NMES Treatment includes-

NMES Parameters: Contraction Time 6 seconds, Relaxation Time 6 seconds, Pulse Mode, Pulse Duration-250 microsecond, Frequency 100 Hz, Treatment Time- 10 Minutes.

Site of Application-Active Electrode was placed over the vastus medialis muscle. The negative pole of the channel was placed longitudinally in a position parallel and distal to the active electrode.

Group B received Conventional Physiotherapy**.** Conventional Physiotherapy after TKA includes Ankle Pumps, Straight Leg Raise, Short-arc Knee Extension, and seated single Leg Knee Extension.

Ankle Pumps are performed through repeated maximum dorsiflexion of the ankle for 10 seconds and plantarflexion for a maximum of 10 seconds. Straight Leg Raise an exercise in which the operated leg is lifted while maintaining maximum extension.

Short Arc Knee Extension contracts the knee extensor muscle of the operated leg and presses the knee toward the bed for 5 seconds. At this time, the knee is extended as much as possible.

Seated single leg knee extension extends the operated knee as much as possible while sitting in a chair.

The Exercise were provided for total 5 sessions/week for 8 weeks

The patients were reassessed at the end of 4^{th} and 8^{th} week.

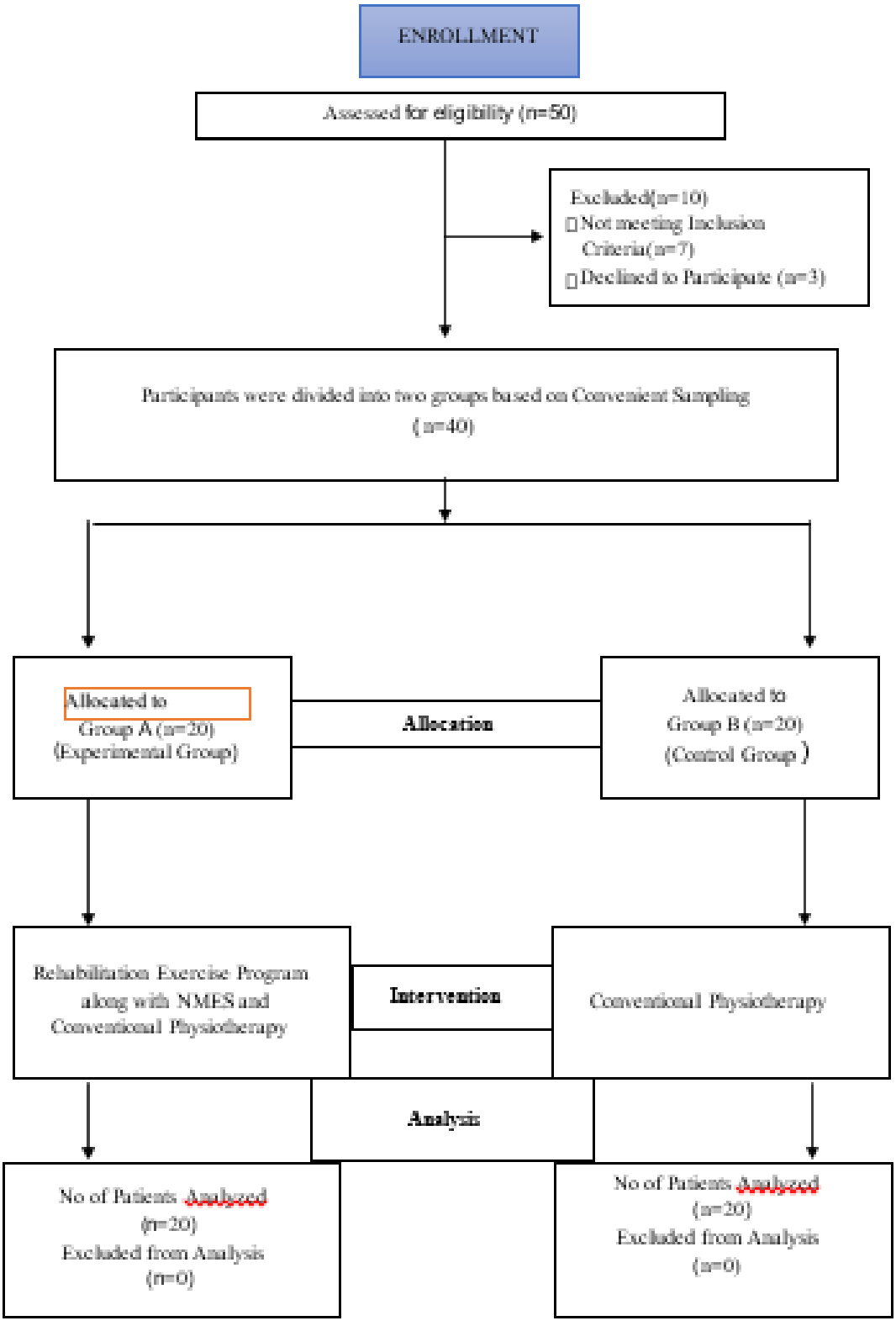


Fig. 1.1 Consort Flow Chart

Statistical Analysis:

Data was analysed using SPSS version 20. Unpaired t-test was used to ascertain the significance of differences between mean values and SD of two Groups. The p value<0.05 was considered as the cut off value or significance.

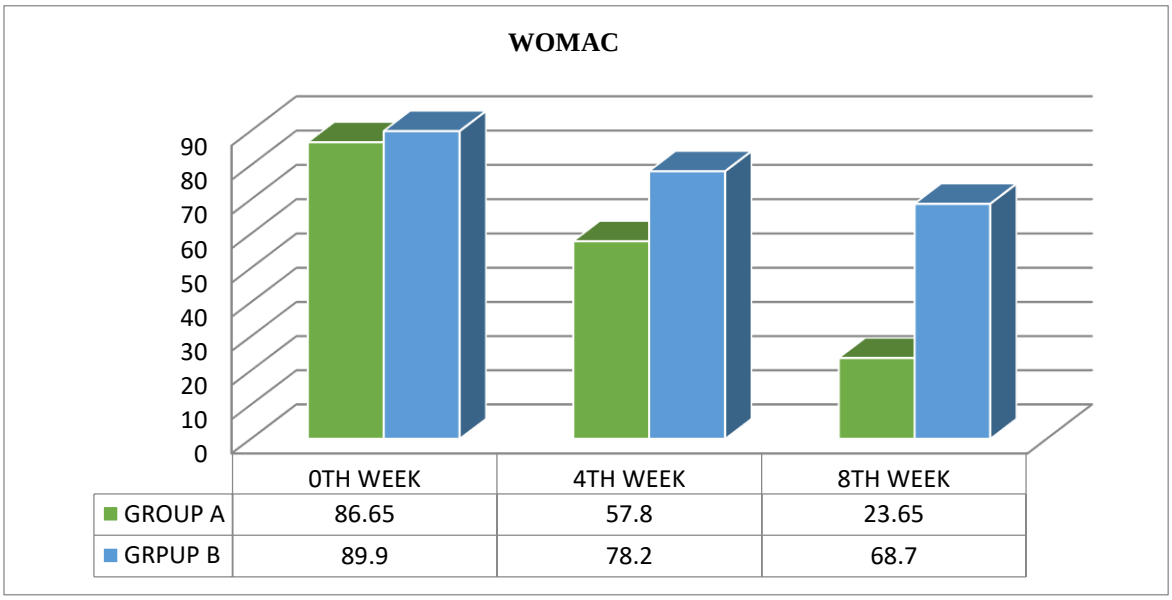
III Results

The Western Ontario and McMaster Universities Arthritis Index (WOMAC):

There was non-significant difference at 0^{th} week. But there was significant difference at 4^{th} and 8^{th} week between both the Groups A and B. But there was highly significant difference in WOMAC in Group A as compared to Group B (p-value <0.05) at the end of 8^{th} week.(Table no. 1.2)

Table no.1.2 Unpaired t-test for Comparison at 0^{th} Week, 4^{th} Week and 8^{th} Week Score Measurements of WOMAC between Group A and Group B

	0^{th}Week		**4thWeek**		**8^{th}Week**	
	Group A	Group B	Group A	Group B	Group A	Group B
Mean	86.65	89.9	57.8	78.2	23.65	68.7
S.D.	6.098	4.854	5.492	6.101	6.95	8.52
Number	20	20	20	20	20	20
Mean Difference	-3.25		-20.4		-45.05	
Unpaired t-test	1.865		11.113		18.316	
P-value	0.0699*		0.0000*		0.0000*	
Result	Not Significant		Significant		Significant	



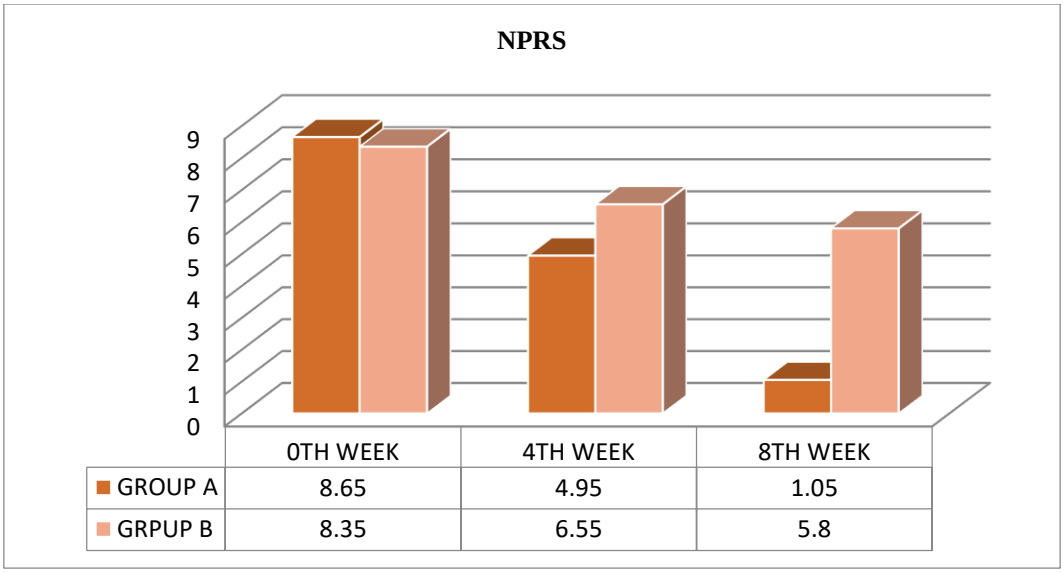
Numerical pain rating Scale (NPRS):

There was non-significant differnce at 0^{th} week and significant difference at 4^{th} and 8^{th} week between both the Groups A and B. On comparison between both the groups revealed that there was highly significant difference in NPRS in Group A (p-value<0.05) at the end of 8^{th} week. (Fig.1.3)

Table no.1.3 Unpaired t-test for Comparison at 0^{th} Week, 4^{th} Week and 8^{th} Week Score Measurements of NPRS between Group A and Group B

	0^{th}Week		**4thWeek**		**8^{th}Week**	
	Group A	Group B	Group A	Group B	Group A	Group B
Mean	8.65	8.35	4.95	6.55	1.05	5.8
S.D.	0.745	0.745	1.050	0.998	1.05	0.833
Number	20	20	20	20	20	20
Mean Difference	0.3		-1.6		-4.75	

Unpaired t-test	1.273	4.938	15.844
P-value	0.211	0.0000*	0.0000*
Result	Not-Significant	Significant	Significant

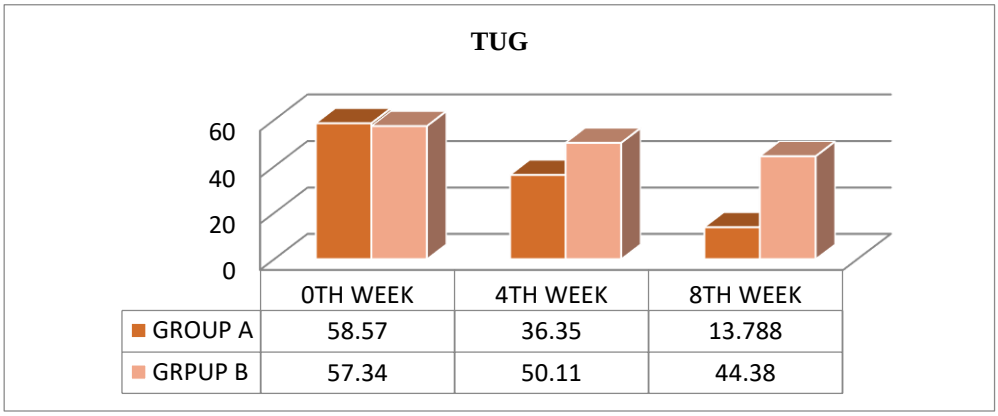


Time up and Go Test:

There was non-significant differnce at 0^{th} week but there was significant difference at 4^{th} and 8^{th} week between both the Groups A and B. But there was highly significant difference in TUG in Group A as compared to group B (p-value<0.05) at the end of 8^{th} week.(Table no.1.4)

Table no.1.4 Unpaired t-test for Comparison at 0^{th} Week, 4^{th} Week and 8^{th} Week Score Measurements of TUG between Group A and Group B

	0^{th}Week		4thWeek		8^{th}Week	
	Group A	Group B	Group A	Group B	Group A	Group B
Mean	58.57	57.34	36.35	50.11	13.788	44.38
S.D.	3.509	3.489	5.014	4.815	2.421	6.06
Number	20	20	20	20	20	20
Mean Difference	1.23		-13.76		-30.592	
Unpaired t-test	1.121		8.851		20.964	
P-value	0.269		0.0000*		0.0000*	
Result	Not-Significant		Significant		Significant	

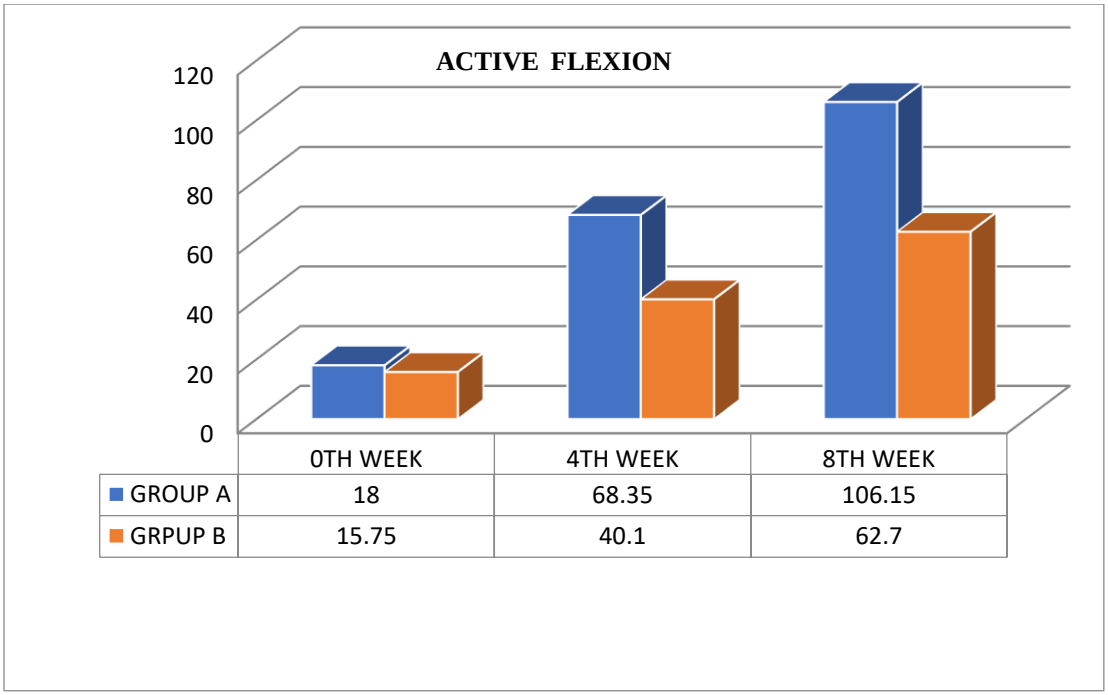


Active Flexion:

There was non- significant difference at 0th week but there was significant difference at 4th and 8th week between both the Groups A and B. But there was highly significant difference in Active Flexion in Group A as compared to Group B (p-value<0.05) at the end of 8th week.(Table no.1.5).

Table no.1.5 Unpaired t-test for Comparison at 0th Week, 4th Week and 8th Week Score Measurements of Active Flexion between Group A and Group B

	0thWeek		4thWeek		8thWeek	
	Group A	Group B	Group A	Group B	Group A	Group B
Mean	18.0	15.75	68.35	40.1	106.15	62.7
S.D.	7.504	6.077	13.31	9.95	8.98	9.45
Number	20	20	20	20	20	20
Mean Difference	2.25		28.25		43.45	
Unpaired t-test	1.042		7.600		14.906	
P-value	0.304		0.0000*		0.0000*	
Result	Not- Significant		Significant		Significant	

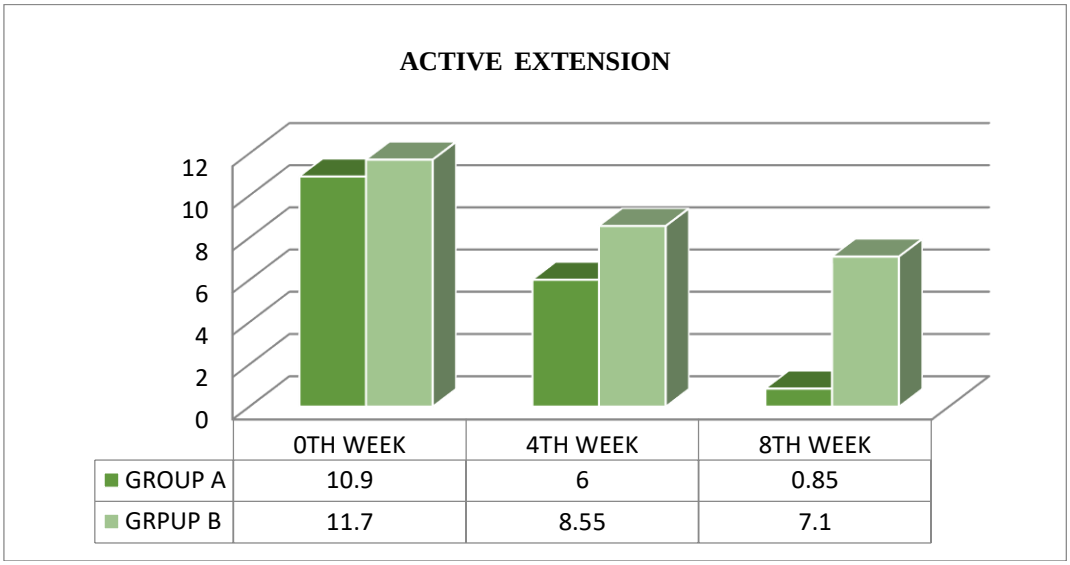


Active Extension:

There was non significant difference at 0th week. But there was significant difference at 4th and 8th week between both the Groups A and B. But There was highly significant difference in Active Extension in Group A as compared to Group B (p-value <0.05) at the end of 8th week.(Table no.1.6).

Table no.1.6 Unpaired t-test for Comparison at 0th Week, 4th Week and 8th Week Score Measurements of Active Extension between Group A and Group B

	0thWeek		4thWeek		8thWeek	
	Group A	Group B	Group A	Group B	Group A	Group B
Mean	10.9	11.7	6.0	8.55	0.85	7.1
S.D.	3.161	3.614	2.362	2.982	1.226	2.382
Number	20	20	20	20	20	20
Mean Difference	-0.8		-2.55		-6.25	
Unpaired t-test	0.745		2.997		10.434	
P-value	0.461*		0.0000*		0.0000*	
Result	Not Significant		Significant		Significant	

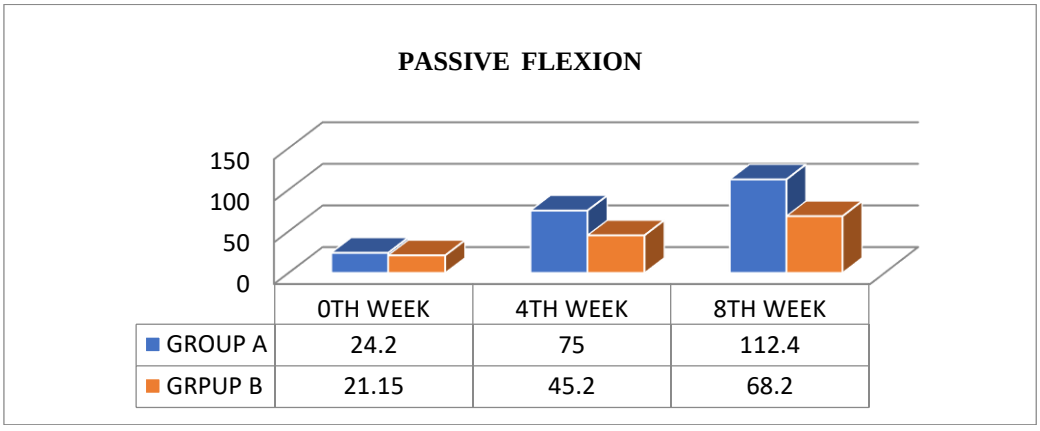


Passive Flexion:

There was non-significant differnce at 0th week but there was significant difference at 4th and 8th week between both the Groups A and B. But there was highly significant difference in Passive Flexion in Group A as compared to Group B (p-value<0.05) at the end of 8th week.(Table no. 1.7).

Table no.5.8 Unpaired t-test for Comparison at 0th Week, 4th Week and 8th Week Score Measurements of Passive Flexion between Group A and Group B

	0th Week		4th Week		8th Week	
	Group A	Group B	Group A	Group B	Group A	Group B
Mean	24.2	21.15	75.0	45.20	112.4	68.20
S.D.	6.598	6.539	13.255	9.51	7.81	9.08
Number	20	20	20	20	20	20
Mean Difference	3.05		29.8		44.2	
Unpaired t-test	1.468		8.169		16.509	
P-value	0.150		0.0000*		0.0000*	
Result	Not-Significant		Significant		Significant	

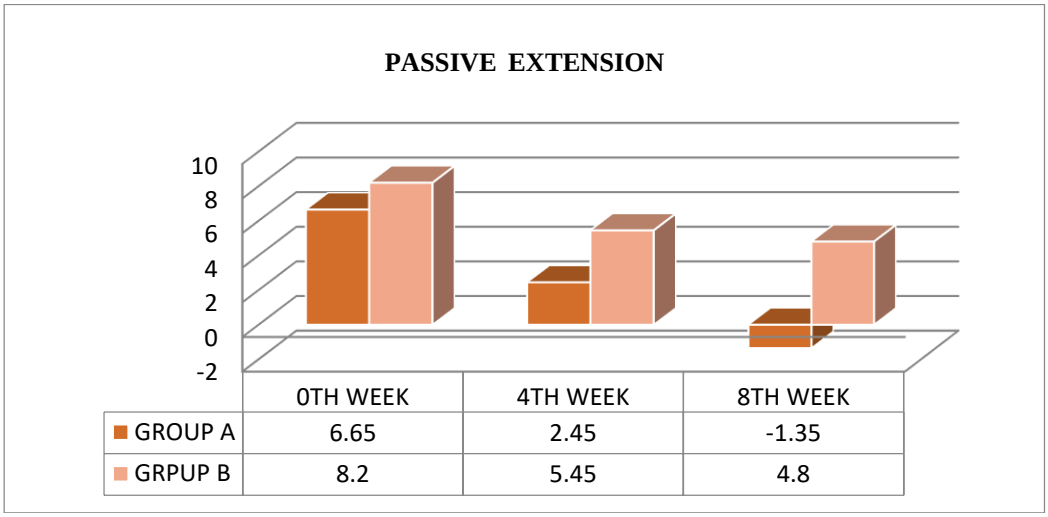


Passive Extension:

There was non-significant difference at 0th week. But there was significant difference at 4th and 8th week between both the Groups A and B. There was highly significant difference in Passive Extension in Group A as compared to Group B (p-value <0.05) at the end of 8th week.(Table no.1.8).

Table no.1.8 Unpaired t-test for Comparison at 0th Week, 4th Week and 8th Week Score Measurements of Passive Extension between Group A and Group B

	0th Week		**4th Week**		**8th Week**	
	Group A	Group B	Group A	Group B	roup A	Group B
Mean	6.65	8.20	2.45	5.45	-1.35	4.80
S.D.	2.498	2.764	1.932	1.669	1.598	1.908
Number	20	20	20	20	20	20
Mean Difference	-1.55		-3.0		-6.15	
Unpaired t-test	1.860		5.254		11.048	
P-value	0.076*		0.0006*		0.0000*	
Result	Not Significant		Significant		Significant	

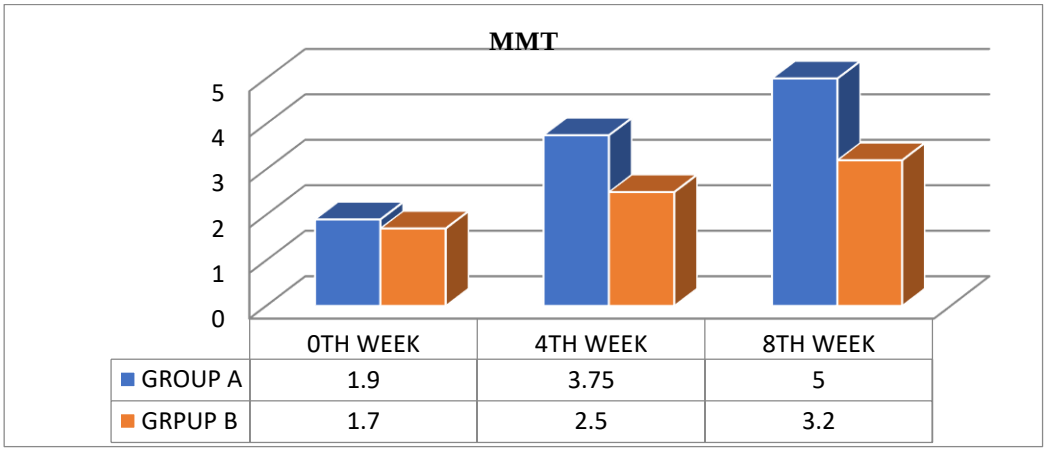


Manual muscle Testing (MMT):

There was non-significant differnce at 0th week and significant difference at 4th and 8th week between both the Groups A and B. But there was highly significant difference in MMT in Group A as compared to Group B (p-value<0.05) at the end of 8th week.(Table no 1.9)

Table no.1.9 Unpaired t-test for Comparison at 0th Week, 4th Week and 8th Week Score Measurements of MMT between Group A and Group B

	0th Week		**4th Week**		**8th Week**	
	Group A	Group B	Group A	Group B	Group A	Group B
Mean	1.9	1.7	3.75	2.5	5.0	3.2
S.D.	0.641	0.657	0.444	0.513	0.0	0.410
Number	20	20	20	20	20	20
Mean Difference	0.2		1.25		1.8	
Unpaired t-test	0.975		8.234		19.615	
P-value	0.336		0.0000*		0.0000*	
Result	Not-Significant		Significant		Significant	



	0TH WEEK	4TH WEEK	8TH WEEK
GROUP A	1.9	3.75	5
GRPUP B	1.7	2.5	3.2

IV. Discussion

The result of the study supports the beneficial effect of Mintken Rehabilitation Exercise Program along with NMES and Conventional Physiotherapy as well as Conventional Physiotherapy alone are effective in reducing knee pain, improving quadriceps strength, increasing range of motion and improving functional outcomes in post-operative TKA Patients. However, statistically it was concluded that Rehabilitation Exercise Program along with NMES and Conventional Physiotherapy are better than Conventional Physiotherapy alone in decreasing knee pain, increasing range of motion and improving quadriceps strength and functional outcomes.

The results of the present study are supported by the study of Stephanie Petterson[4] et al (2009) in which an Exercise Group received Mintken Outpatient Physiotherapy 2-3 times a week for 6 weeks and an Exercise NMES Group received Mintken Outpatient Physiotherapy and NMES. NMES component consists of 10 electrically elicited contractions of the quadriceps femoris muscle. The findings of the study concluded that Progressive Quadriceps Strengthening with or without NMES enhances clinical improvement after TKA achieving similar short and long-term functional recovery and approaching the functional level of healthy older adults.

The results of the present study are comparable with the study conducted by Yasuyoshi Asakawa[8] et al (2014) in which Experimental Group (n=10) received strength training of lower limb for 20min/day, for 5days/week for 4 weeks along with NMES with incremental increase in intensity of isometric contraction for 4 weeks and Control Group (n=10) received strength training of lower limb for 20min/day, 5 days/week for 4 weeks. The findings of the study suggested that additional NMES along with exercise is more beneficial in improving lower limb pain and strength in patients with instability after knee surgery.

The results of the present study are similar to study conducted by Demet Tekdos Demircioglu[9] et al (2015) in which Experimental Group received NMES and Control group received Exercise alone. For the NMES Group 30 minutes Electrical Stimulation was applied to the vastus medialis muscle 5 days a week for 4 to 6 weeks. The findings of the study suggested that significantly better Physical Function and SF-36 subscale were found for the NMES Group. The inclusion of the NMES Program after Total Knee Arthroplasty was more effective at providing Rapid improvement in knee pain, walking distance and quality of life.

V. Conclusion

This study concluded that both Rehabilitation Exercise program along with NMES, Conventional Physiotherapy and Conventional Physiotherapy alone are effective in reducing Knee Pain, increasing Knee ROM, Quadriceps Strength and Functional Outcomes. However, statistically it is proved that reduction in pain, increase in ROM, Quadriceps Strength and Functional Outcomes is more at the 8th week in patients who received Rehabilitation Exercise Program along with NMES and Conventional Physiotherapy as compared to the patients who received Conventional Physiotherapy alone with statistical significance of $p<0.05$.

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