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"To compare the efficacy of Enhanced Recovery Program versus Pilates Based Exercise in Pre-Post-Operative Total Knee Replacement Rehabilitation."

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Abstract
Occupational Therapy in India has been misunderstood and this has affected its programmes and services as persons with disabilities suffered all forms of abuse and discrimination. This study investigated strategies that guaranteed security for Occupational Therapy in India. The study adopted survey as its design, guided by a research question and questionnaire was designed by the researcher, validated by experts in Occupational Therapy, educational research and measurement and used as instrument for data collection. Two hundred Participants were purposively sampled and used for the study, Descriptive statistics was used to analyzed data from the field and findings revealed that 82 (41% =SA), 59 (30%= A) of the participants agreed that, collaborative mechanism, formation of people with disabilities organizations, improved funding, professional associations, establishment of ministry or commission for Occupational Therapy and improved awareness/advocacy promotes security for Occupational Therapy. On other hand 38 (19%=SD), 21(10%=D) disagreed that aforementioned strategies do not contribute to security of Occupational Therapy. Considering the number and percentage of responses criteria, the study concluded that the above-mentioned strategies promote security of Occupational Therapy and by implication protects persons with disabilities from abuse and discrimination. It was recommended among others that stakeholder particularly government should promptly put in place workable network for effective collaboration in the provision of security for Occupational Therapy and persons with disabilities in India.

Keywords: security, collaboration, Occupational Therapy, disability

Introduction
Nowadays, we work at an office where most of our time is at our desk, or maybe when we are at home, we prefer to rest on the couch instead of being on our feet. Many people live a mostly inactive lifestyle, but they might not realize that inactivity can be the reason why they experience increased joint pain [(1)] If we live a life of limited activity, our body adapts to that lack of motion. Essentially, when we aren't using our legs muscles, ligaments, and joints for moderate levels of activity, we are losing them. [(2)]

Knee is the foremost joint and a major weight-bearing point in the human body. Knee plays a vital role in all the body movement as well as helps support body weight. It's no doubt that a healthy and strong knee is requisite for an active life style. However, injuries, worn out cartilage or other medical conditions like arthritis and osteoarthritis can cause inflammation, pain and restrict knee flexibility, which subsequently leads to knee arthroplasty. [(3)]

According to the International Classification of Functioning, Disability and Health (ICF) is a framework for describing functioning and disability in relation to a health condition. The ICF is a framework to approach patient care that shifts the conceptual emphasis away from negative connotations such as disability and places focus on the positive abilities of the individual at the patient level rather than the systems level. According to the framework and classification we can define the typical spectrum of problems in functioning of patients with OA. [(4)]

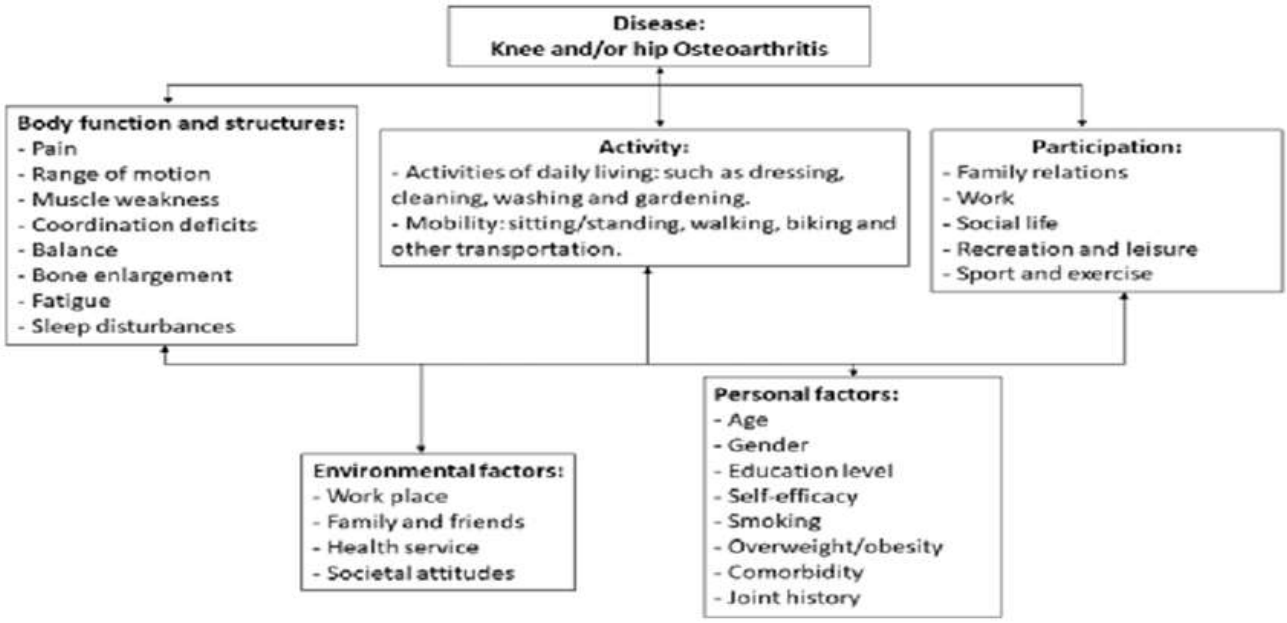


Fig. 1: Icf Model for Oa Knee.

There are two types of knee replacement surgeries; Total Knee Replacement and Partial Knee Replacement. The Total knee replacement surgery is suggested for patient who are experiencing severe knee pain or stiffness. Knee pain even during sitting or lying down, chronic inflammation or swelling and knee deformities among the other reasons. The Partial Knee Replacement is recommended for patients with arthritis limited to one area of the knee. [5]

Enhanced recovery Program is a new approach to the way that care can be delivered to patients having undergone a certain surgery. Enhanced recovery is a fully structured and well-organized sequence of clinical care called a care pathway. Enhanced recovery improves the way in which health care is organized to allow you to get better sooner after your operation. Research indicates that after surgery the earlier you get out of bed and start eating and drinking, the better your recovery will be, and complications are less likely to occur. [6]

The goals evolve postoperatively. Guided by the Pilates principles of initiating movements from a stable source, performance of active and active-assisted exercises to increase knee range of motion (within postoperative guidelines), early strengthening, and development of muscle memory for the knee (flexors and extensors). Slow and controlled performance of these exercises will help strengthen the core muscles, improve knee range of motion, enhance the stamina of adjacent muscles and joints, and improve ambulatory capacity. [7]

Need of the Study

After an extensive literature search, individual studies were found using Enhanced recovery program and Pilates based exercise but they've not been compared. Hence this study was undertaken to compare between them in TKR and this study will help to increase the evidence base of these programs. Many therapeutic approaches that have been used to treat a person with total knee replacement include manual therapy, electrical modalities, active exercises, and various basic and advanced joint mobilization techniques. The purpose of this study was to determine the functional skills achieved after total knee arthroplasty (TKA) in patients who were treated with either Enhanced Recovery Program or Pilates based exercise.

Aims And Objectives

AIM: To compare the efficacy of Enhanced Recovery Program versus Pilates Based Exercise in Pre-Post-Operative Total Knee Replacement Rehabilitation.

Objectives

Primary Objective: Reduce person's occupational performance deficits

Secondary Objective: To manage the pain and disability associated with Total Knee Replacement.

Materials And Methodology

Study Design

This study was an experimental, Interventional, comparative study. Method of randomization was done by Block Randomization using Simple Random Sampling. Study protocol, informed consent documents, case Record form were reviewed and approved by Institutional Ethics Committee. The study was initiated after receiving an approval from Institutional Ethics Committee as well as The Maharashtra University of Health Sciences.

Sample Size

With the help of difference in the mean formula at 90% power and 5% α- error minimum sample size was found to be 25 per group. There was total 50 subjects participating in the study, 25 in group A (Enhanced Recovery Program and 25 in group B (Pilates based exercise).

Inclusion Criteria

1. Participants willing to participate in the study.
2. Individuals undergoing Total Knee Replacement
3. Both male and female subjects aged between 45- 65 years
4. Revision surgery for knee replacement.

Exclusion Criteria

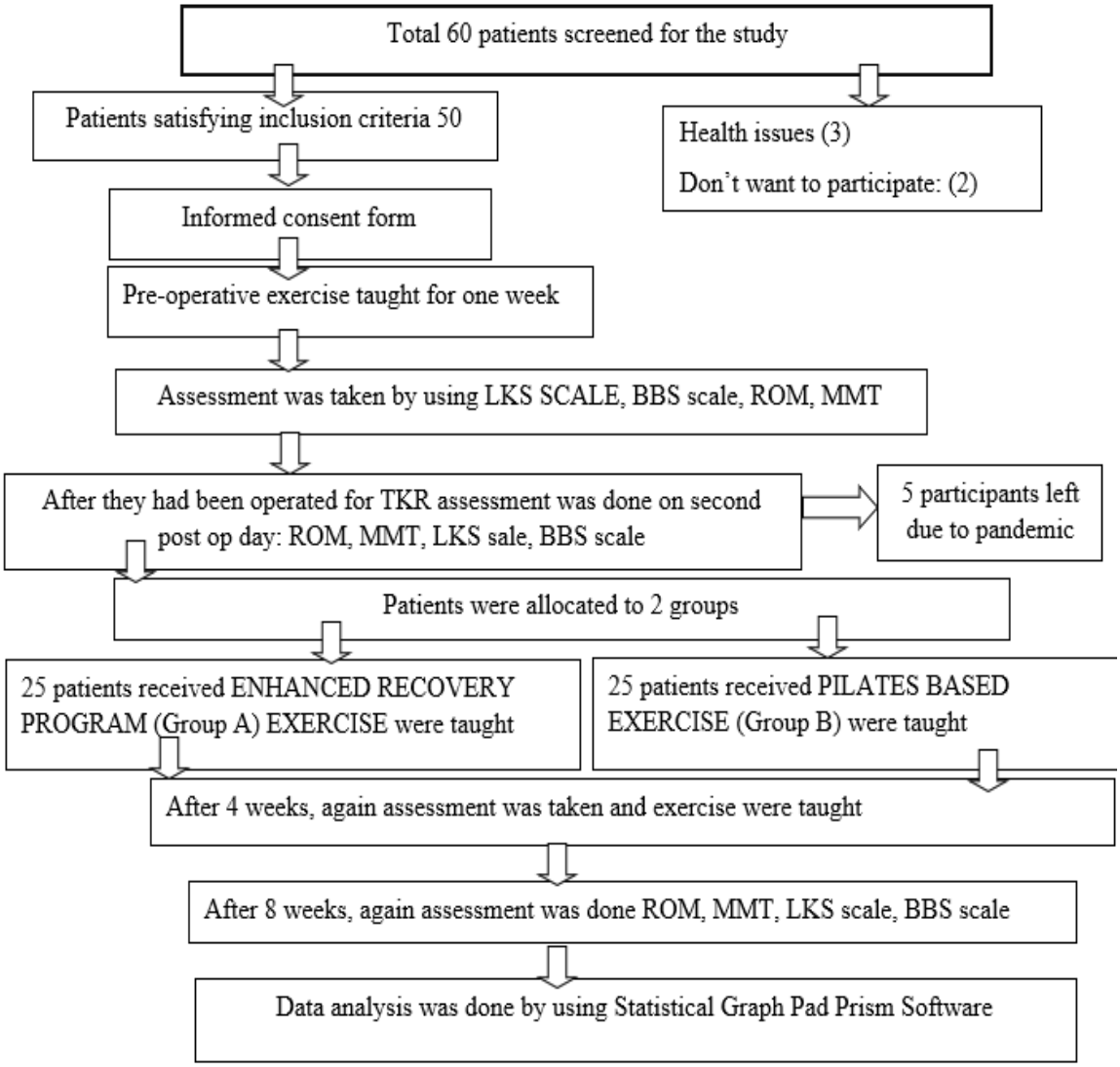
1. Any history of fracture of hip, knee, ankle
2. Recent incidence of knee injuries
3. Cognition impaired
4. Not willing to participate

Assessment Parameters

- Range Of Motion of Knee Joint
- Manual Muscle Testing of Knee Joint:
- Scales

Lysholm Knee Scoring Scale[8]
Berg Balance Scale[9]

Flow Chart of Sampling Method



Result

The study was conducted on 50 patients, of age group 45-65 years who fulfilled the inclusion criteria and followed up for the period of 8 weeks of intervention. The study was conducted in Occupational Therapy department of tertiary care hospital, Nagpur.

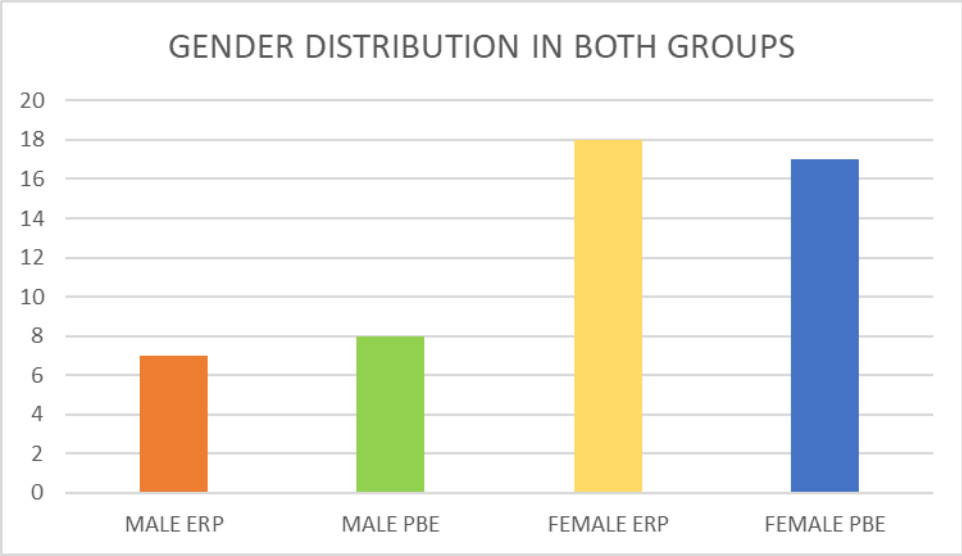
Outcome measures were:

- Berg balance scale (BBG)
- Lysholm knee scoring scale
- ROM of knee joint using goniometer (ROM)
- Manual Muscle Testing (MMT)

Patients were evaluated one week pre-operatively, postoperatively on 2nd day, after 4 weeks, and lastly after 8 weeks' duration. Collected data were entered into Microsoft Excel spreadsheet. Continuous variables were presented as mean ± SD. categorical variables were expressed in frequency and percentages. Continuous variables (BBG score, LKS score, ROM, MMT) were compared at different follow-up period in each group by performing one-way repeated measure ANOVA. Post hoc comparison were performed by Bonferroni t-test. Change in these study parameters at post-op, 4th weeks and 8th weeks from baseline between 2 groups were compared by independent t-test for normalized data and Mann-Whitney test for non - normalized data. $P<0.05$ was considered as statistical significance. Statistical Graph Pad Prism Software was used for data analysis.

Table 1: Total number of male and female as per the groups.

Table: Total number of male and female participated in the study			
Male ERP	Male PBE	Female ERP	Female PBE
7	8	18	17

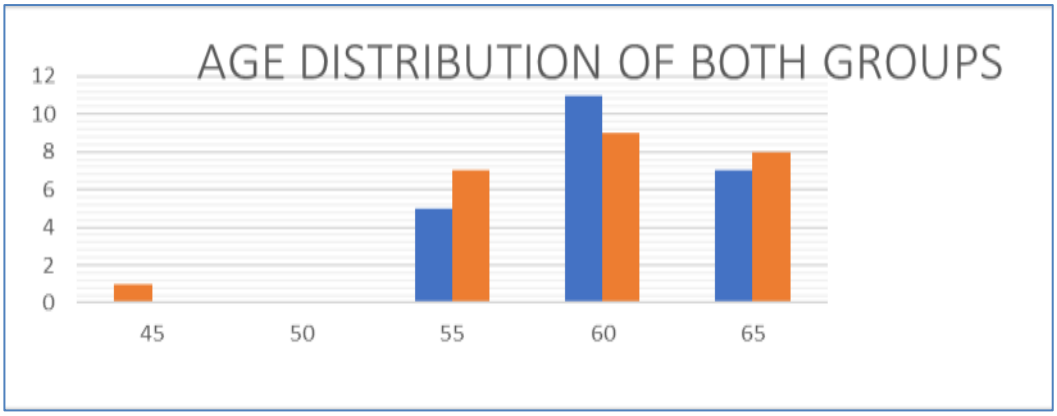


Graph No. A: Gender distribution of study population.

Table no 1 graph no A, shows that, total 50 patients were recruited in the study. The group A, had 7 males and 18 females whereas 8 patients were males and 17 were females in group B.

Table No.2: Age distribution of study population.

Table No 2: Frequency distribution of the patients as per age with five years of interval		
Bonferroni's Centre	(ERP) Group A	(PBE) Group B
45.	1.000	0.000
50.	0.000	0.000
55.	5.000	7.000
60.	11.000	9.000
65.	7.000	8.000
70.	1.000	1.000



Graph B: Age distribution of study population.

Table 2 and Graph B show the age distribution in both groups. The total no of sample is 50, that is between 45-50 yrs. no of sample is 01, between 50-55yrs is 0 between 55-60yrs is 12, between 60-65 is 20, between 65-70 is 15 and 70-75 yrs. is 2. Mean age of is 60.72 group 1 and is 60.56 group 2.

Table No.3: As per the ANOVA test the significance values recorded Group A on Range of Motion (ROM).

Bonferroni's Multiple Comparison Test	Mean Diff.	t	Significant P < 0.05
PRE vs POST-OP	62	28	Yes
POST-OP vs 4th WEEKS	-52	-24	Yes
4th WEEKS vs 8th WEEKS	-10	-3.9	Yes
POST-OP vs 8th WEEKS	-62	-32.2	Yes

Table no 3: The significant difference was found in values of Group A for ROM. From pre-op to post-op mean difference value is 62 and t value was 28. 689from post-op to 4th week the mean difference was -52 and t value was -24. from 4th week to 8th week mean difference was -10 and t value was -3.9. Post-op to 8th the mean difference is -62 and t value was -32.2

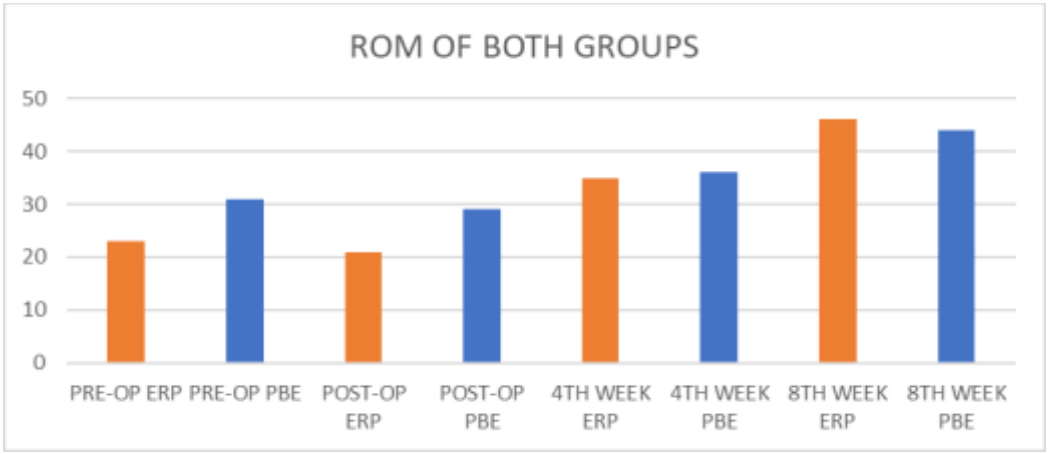
Table no.4: As per the ANOVA test the significance values recorded in Group B on Range of Motion (ROM).

Bonferroni's Multiple Comparison Test	Mean Diff.	t	Significant P < 0.05
PRE vs POST-OP	62	-3.29	No (0.003)
POST-OP vs 4th WEEKS	52	23.4	Yes
4th WEEKS vs 8th WEEKS	-2	-5	No (0.04)
POST-OP vs 8th WEEKS	-57	-34	YES

Table no 4: The significant difference was found in values OF Group B for ROM. From pre-op to post-op mean difference value is 62 and t value was -3.29. from post-op to 4th week the mean difference was 52 and t value was 23.4. from 4th week to 8th week, mean difference was -2 and t value was -5. from post-op to 8th weeks, mean difference is -57 and t value was -34

Table no 5: Comparison of RANGE OF MOTION (ROM) at different time point in Two Group.

Groups	ERP	PBE	P-value	Are means significantly different? (P < 0.05)
	Mean ± Std. Dev.			
PRE-OP	110±10	110±9.4	0.8286	NO
POST-OP	48±4.3	48±4.8	0.4389	NO
4th Week	100±9.5	100±10	0.0604	NO
8th Week	110±8.8	105±6.6	0.0453	YES*



Graph C: Comparison of Range of Motion (ROM) at different time point in 2 Groups

The Table No. 5 indicates inter-group comparison of the results for ROM. it shows that there was no difference between the two groups for the range of knee joint up to 4 weeks. But there is significant difference in ranges at 8 weeks. In which group A show better result than group B.

Table No.6: As per the ANOVA test the significance values recorded Group A on Manual Muscle Testing (MMT).

Bonferroni's Multiple Comparison Test	Mean Diff.	t	Significant P < 0.05
PRE vs POST-OP	1.1	7.05	Yes
POST-OP vs 4th WEEKS	-0.6	-5.8	Yes
4th WEEKS vs 8th WEEKS	-0.1	0.7	No
POST-OP vs 8th WEEKS	0.7	7.29	Yes

Table No 6, a significant difference was found in values of Group A for Manual Muscle Testing (MMT)

From pre-op to post-op mean difference value is 1.1 and t value was 7.05. from post-op to 4th week the mean difference was -0.6 and t value was -5.8. from 4th week to 8th week mean difference was -0.1 and t value was 0.7. Post-op to 8th the mean difference is 0.7 and t value was 7.29.

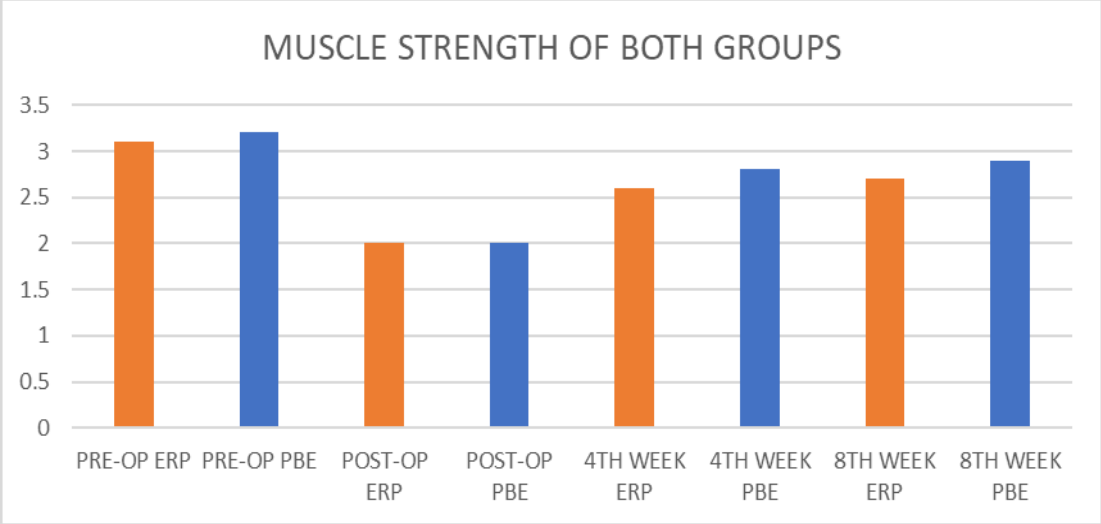
Table No.7: As per the ANOVA test the significance values recorded GROUP B on Manual Muscle Testing (MMT).

Bonferroni's Multiple Comparison Test	Mean Diff.	t	Significant P < 0.05
PRE vs POST-OP	1.2	8.6	Yes
POST-OP vs 4th WEEKS	0.8	10	Yes
4thWEEKS vs 8th WEEKS	-0.1	-0.20	N0(0.83)
POST-OP vs 8th WEEKS	-0.9	-1.87	No (0.07)

Table no 7, a significant difference was found in values of Group B for Manual Muscle Testing (MMT). From pre-op to post-op mean difference value is 1.2 and t value was 86 from post-op to 4th week the mean difference was 0.8 and t value was 10 from 4th week to 8th week mean difference was -0.1 and t value was -0.20 Post-op to 8th the mean difference is -0.9 and t value was -1.87.

Table No.8 Comparison of Manual muscle testing (MMT)at different time points in 2 Groups.

Groups	ERP	PBE	P-value	Are means significantly different? (P < 0.05)
	Mean ± Std. Dev.			
PRE-OP	3.1±0.78	3.2±0.69	0.4242	NO
POST-OP	2.00±0.00	2.00±0.00	NR	-
4th Week	2.6±0.51	2.8±0.44	0.0706	NO
8th Week	2.7±0.48	2.9±0.33	0.0456	YES*



Graph no D: Comparison of Manual muscle testing (MMT)at different time point in 2 Groups.

Table No. 8 and Graph D represent variation of manual muscle testing at different follow up period in 2 groups. Mean manual muscle testing at pre-op, post-op ,4th weeks & 8th weeks for "Group A" are 3.1,2.0,2.6and 2.7 and for "Group B" are 3.2,2.0,2.8 and 2.9 respectively. The results were found to be significant at the end of 8th weeks for both the groups.

Table no.9 As per the ANOVA test the significance values recorded Group B on BERG BALANCE SCALE SCORE (BBS).

Bonferroni's multiple comparison test	Mean diff.	T	Significant p < 0.05
Pre vs post-op	2	0.82	No (0.281)
Post-op vs 4 weeks	14	5.2	No (0.917)
4th weeks vs 8th weeks	-11	-4.4	Yes
Post-op vs 8th weeks	-2.5	-9.3	Yes

Table no 9, asignificant difference was found in values of Group A for BBS score. From pre-op to post-op mean difference value is 2 and t value was 0.82 from post-op to 4th week the mean difference was 14 and t value was 5.2 from 4th week to 8th week mean difference was -11 and t value was -4.4 Post-op to 8th the mean difference is -2.5and t value was -9.3.

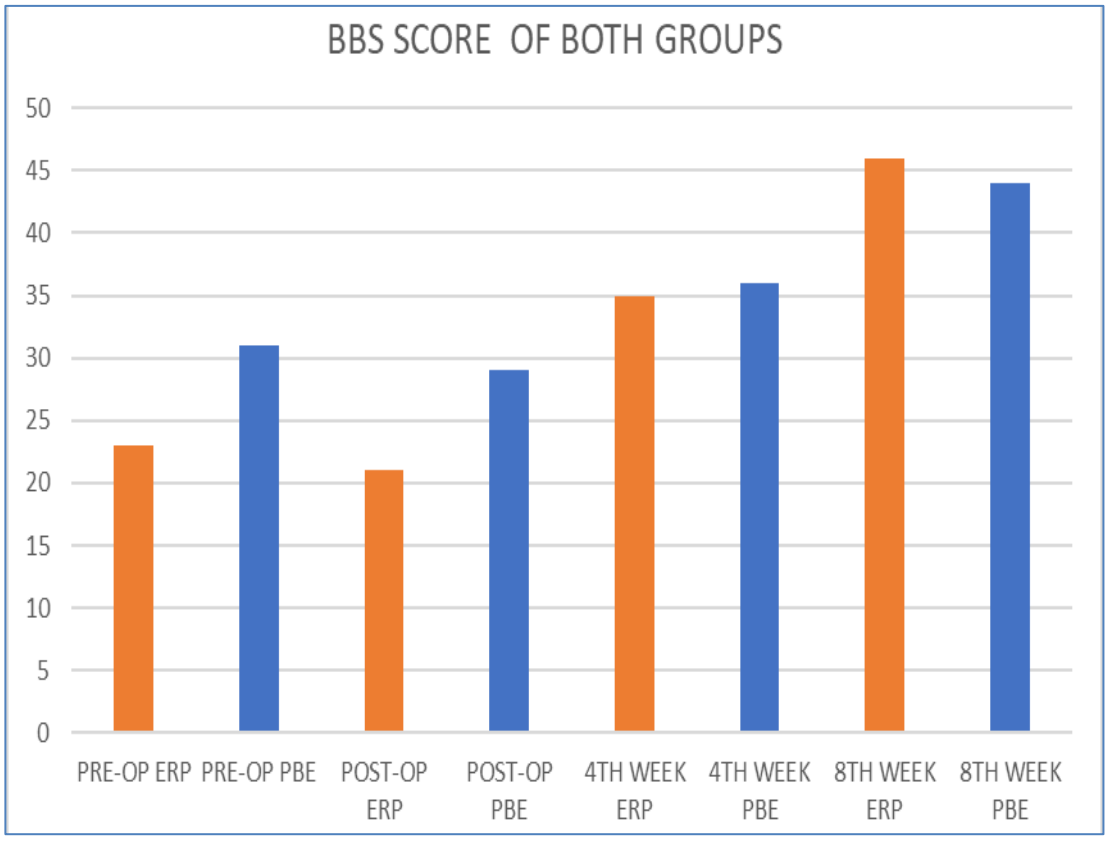
Table No.10: As per the ANOVA test the significance values recorded GROUP 2 on BERG BALANCE SCALE SCORE:

Bonferroni's Multiple Comparison Test	Mean Diff.	t	Significant P < 0.05
PRE vs POST-OP	2	3.2	No
POST-OP vs 4th WEEKS	7	12	Yes
4th WEEKS vs 8th WEEKS	-8	-20.8	Yes
POST-OP vs 8th WEEKS	-13	-28.9	Yes

Table no 10: The significant difference was found in values OF Group B for BBS score. From pre-op to post-op mean difference value is 2and t value was 3.2 from post-op to 4th week the mean difference was 7 and t value was 12 from 4th week to 8th week mean difference was -8 and t value was -20.8 Post-op to 8th the mean difference is -13 and t value was -28.9

Table No.11: Comparison of BERG BALANCE SCALE SCORE at different time points in 2 Groups.

Groups	ERP	PBE	P-value	Are means significantly different? (P < 0.05)
	Mean ± Std. Dev.			
PRE-OP	23±7.6	31±9.4	0.0009	Yes***
POST-OP	21±9.5	29±12	0.0069	Yes**
4th Week	35±9.3	36±7.5	0.3700	NO
8th Week	46±7.7	44±6.2	0.0942	NO



Graph N0.E: Comparison of BERG BALANCE SCALE SCORE at different time points in 2 Groups.

Table No. 11 and Graph E represent variation of BBG score at different follow up period in 2 groups. Mean score at baseline, after, 4 weeks & 8 weeks for "Group A" are 23, 21 ,35 and 46 and for "Group B" are 29, 31, 36 and 44 respectively.

Table No.12: As per the ANOVA test the significance values recorded GROUP 1 on LYSHOLM KNEE SCALE SCORE:

Bonferroni's Multiple Comparison Test	Mean Diff.	t	Significant P < 0.05
PRE vs POST-OP	2	0.53	No (0.593)
POST-OP vs 4th WEEKS	22	6.5	Yes
4th WEEKS vs 8th WEEKS	-10	-3.4	Yes
POST-OP vs 8th WEEKS	-32	-8.6	YES

Table no 12: The significant difference was found in values OF Group A for LKS score. From pre-op to post-op mean difference value is 2 and t value was 0.53 from post-op to 4th week the mean difference was 22 and t value was 6.15 from 4th week to 8th week mean difference was -10 and t value was -3.4 Post-op to 8th the mean difference is -32 and t value was -8.6.

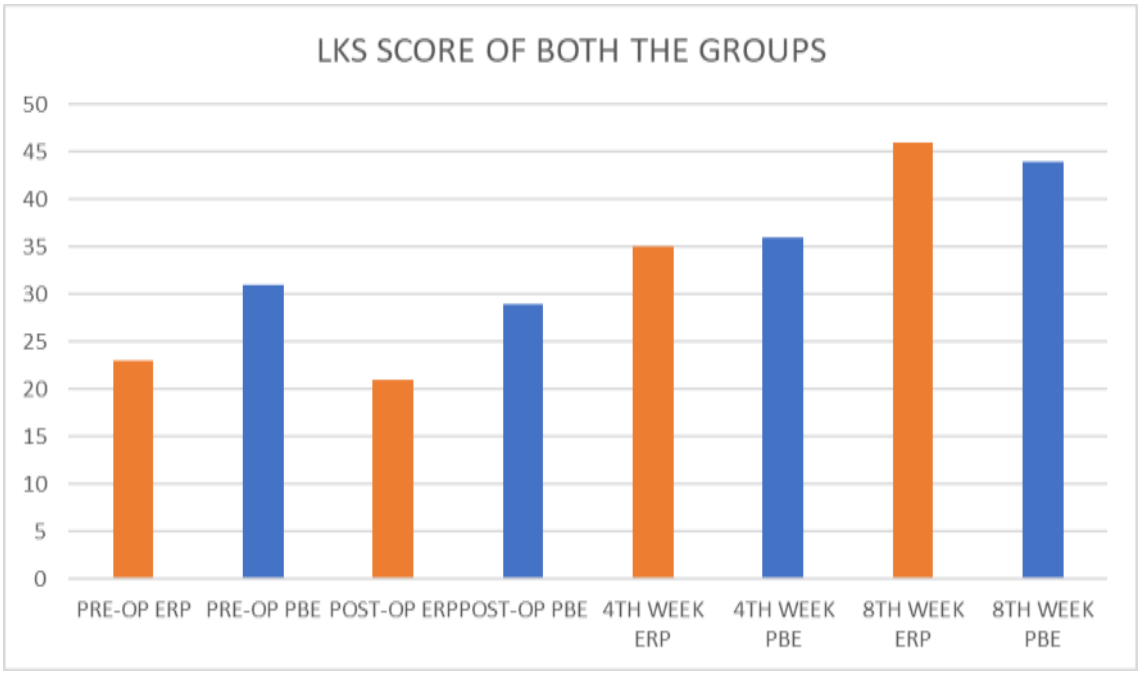
Table No.13: As per the ANOVA test the significance values recorded GROUP 2 on LYSHOLM KNEE SCALE SCORE (LKS score):

Bonferroni's Multiple Comparison Test	Mean Diff.	t	Significant P < (0.05)
PRE vs POST-OP	12	3.03	No
POST-OP vs 4th WEEKS	9	2.3	No
4th WEEKS vs 8th WEEKS	-17	-4.8	N0
POST-OP vs 8th WEEKS	-26	-7.05	Yes

Table No.13, a significant difference was found in values of Group B for LKS score. From pre-op to post-op mean difference value is 12 and t value was 3.03 from post-op to 4th week the mean difference was 9 and t value was 2.3 from 4th week to 8th week mean difference was -4.8 and t value was -17 Post-op to 8th the mean difference is -26 and t value was -7.05

Table No.14: Comparison of LYSHOLM KNEE SCALE SCORE at different time point in 2 Groups.

Groups	ERP	PBE	P-value	Are means significantly different? (P < 0.05)
	Mean ± Std. Dev.			
PRE-OP	46±11	65±14	< 0.0001	Yes***
POST-OP	44±15	63±14	< 0.0001	Yes***
4 Week	66±9.7	71±13	0.0707	NO
8 Week	76±11	79±12	0.1774	NO



Graph No F- Comparison of LYSHOLM KNEE SCALE SCORE at different time point in 2 Groups

Table No. 14 and Graph F represent variation of Lysholm knee scale score at different follow up period in 2 groups. Mean score at baseline, after, 4 weeks & 8 weeks for "Group A" are 46, 44, 66 and 76 and for "Group B" are 63, 65, 71and 79 respectively.

Discussion

The purpose of this study was to investigate and compare the efficacy of Enhanced Recovery Program versus Pilates Based Exercise in pre-post-operative total knee replacement patients.

A sample of 50 patients who underwent total knee replacement were recruited for the study; they were divided into two groups. All the patients received pre-operative exercise for a week. Group A consisted of 25 patients who were given intervention protocol of enhanced recovery program. Group B consisted of 25 patients who were given intervention protocol of Pilates based exercise.

Evaluations of range of motion, manual muscle strength, Berg balance scale, and Lysholm knee score scale were carried out for both groups at one-week pre-operative, post-operative on second day, 4th and 8th weeks.

From Table No.1 & 2 & Graph A & Graph B the mean age for "Group A" was 60.72 years and "Group B" was 60.56 years. The gender wise distribution of male and female in both the groups showed that in "Group A" there were 7 males and 18 females. In "Group B" there were 8 males and 17 females (Table 1, Graph A). As there was no significant difference between the mean ages of the two groups, both groups were comparable. Also, it shows prevalence in females.

This is in accordance with a previous study done by Ana Bracilovic, MD Why Are Women More Prone to Osteoarthritis? Updated: 01/26/2021 Women are 40% more likely to develop knee osteoarthritis than men. The research has shown that there are three possible reason i) Changes in hormone levels: Menopause, Menstruation and joint laxity, ii) Differences in the musculoskeletal system and iii) biomechanics.

Menopause

Women's risk of developing osteoarthritis increases significantly after menopause, and women may notice joint pain appears or worsens during this time. Estrogen levels drop during menopause. This drop may contribute to changes in the body that accelerate the osteoarthritis process.

Menstruation and joint laxity

Increased hormone levels during certain stages of the menstrual cycle may increase joint laxity, which is associated with joint instability and injury.[10] Both joint instability and injury can contribute to the development of osteoarthritis

Differences in the musculoskeletal system and biomechanics

While women's bodies have the same joints as men's, certain musculoskeletal differences exist. These differences alter the way women tend to stand, walk, and run, and how their joint surfaces move in relation to one another (joint articulation). [11]

As per research regular exercise can ease pain in the long term by improving range of motion, muscle tone, strength, and flexibility. Exercise may also cause a release of endorphins, the body's natural painkillers. In both the groups ROM exercise were started on postoperative day one. As postoperative adhesions, generally start immediately after surgery and end on postoperative day 7, surgically damaged tissue emits fibrin, macrophages, and form fibroblasts. During the recovery process of inflammation, the fibroblasts begin to form fibrous tissue on postoperative day 2–3, followed by the appearance of angiogenesis and neuroblasts. The fibrous tissue organizes and adhere in postoperative day 5–7. Starting ROM exercise within 24 hours after surgery have prevented the occurrence of postoperative adhesions around the knee joint, contributing to amelioration of pain and increase in range. [12]

It has been found that if there is a loss of knee flexion then that will cause altered gait pattern affecting the ankle and hip, limited functional squatting, and difficulty negotiating stairs and sitting. The loss of knee extension can cause

altered gait pattern affecting the ankle and hip, inability to attain the closed packed position of the knee. Due to these complications regaining full functional ROM through treatment is crucial. [13]

The table no 3, represents Post hoc analysis of range of motion of group A. There was significant difference in pre to post-op, post-op to 4th week and in 4th to 8 weeks, there was significant difference found in post-op to 8th weeks in ROM of group A. The treatment strategy used in group A (Enhanced Recovery Program) as per the protocol was taught. As we do exercise there is increase in blood flow that helps to rise muscle temperature due to which the muscles are relaxed, relieving tightness and tension. Relieving muscle tightness and tension allows a muscle to stretch to its full length with no restriction, therefore there is increase in range of movement. According, to the table no 3 there is improvement in ROM of group A. This is in accordance with previous study done by Rosemont, Rapid recovery protocol can lead to increased range of motion after total knee arthroplasty American Academy of Orthopaedic Surgeons Nov 09, 2020. The results of this study showed that the mean length of stay (LOS) for the Rapid recovery protocol (RRP) group was 1.8 days, compared to the Standard Recovery Program (SRP) group's mean LOS of 2.5 days. In addition, Rapid recovery protocol (RRP) was associated with a higher flexion, or range of motion, in the 12 weeks after the procedure. [14]

Also, in accordance with previous study done by Jiang HH, Jian XF, et al. Effects of Enhanced Recovery After Surgery in Total Knee Arthroplasty for Patients Older Than 65 Years. Orthop Surg. 2019;11(2):229-235. The study concluded that ERAS program is safer and more efficacious in elderly TKA patients compared to the traditional pathway. As the exercise should be done 4-5 times in a day. ERP effectively relieve perioperative pain and improve joint function, and reduce blood transfusion, length of stay, and total complications without increasing short-term mortality. This led to increase in ranges. [15]

The table no 4, represents Post hoc analysis of range of motion of group B. There was no significant difference in pre to post-op phase, but there was significant difference between post-op to 4th week but for 4th to 8thweeks there was no significant difference, there was highly significant difference found in post-op to 8 weeks in ROM of Group B. The treatment strategy used in group B was Pilates based program. As shown in table no 4 there is significant improvement in ROM of knee joint. This is in accordance with the previous study done by Levine B, Kaplanek B, Jaffe WL.Clin Orthop 'Pilates training for use in rehabilitation after total hip and knee arthroplasty: a preliminary report'. In Relation Res. 2009 Jun;467(6):1468-75. They concluded that at 1-year follow up, review of patient charts and follow-up telephone calls revealed; 25 patients were extremely satisfied and 13 were satisfied with their outcome and use of Pilates in their rehabilitation. Pilate's training is intended to improve general body flexibility and health by emphasizing "core" (truncal) strength, posture, and coordination of breathing with movement. [1]

Within the limitation of standard protocol of achieving the ROM after total knee replacement mean differences are seen in the table 3 and 4. From day 1 to 2 weeks the goal: 65-90- degree. From 2-6 weeks the goal: 90-degree flexion or greater, 6-12 weeks the goal is 115-degree flexion or greater.

The Table No. 5 indicates inter-group comparison of the results for ROM. it shows that there was no difference between the two groups for the range of knee joint up to 4 weeks. But there is significant difference in ranges at 8 weeks. In which group A show better result than group B.

The Table No. 6, represents Post hoc analysis of muscle strength of group A represents that there was significant difference in pre to post-op, post-op to 4th week but no significant difference between 4th to 8 weeks, but there was highly significant difference found in post-op to 8th weeks in muscle strength of Group A. The treatment strategy used in group A (enhanced recovery program) as per the protocol was taught. Due to reduce deconditioning time in hospital and early mobilization after the surgery can improve the muscle strength in TKR patients as shown in the table 6. The ERP program benefits the patient reducing muscle wasting and improving mobility and also help in reducing the risk of blood clots by getting up and moving sooner. This led to increase of muscle strength.

More than 90 percent of the total volume of a skeletal muscle cell is composed of muscle proteins, including the contractile proteins actin and myosin. When a muscle cell is activated by its nerve cell, the interaction of actin and myosin generates force through so-called power strokes. The total force depends on the sum of all the power strokes occurring simultaneously within all of the cells of a muscle. Overall, two processes appear to be involved: hypertrophy, or the enlargement of cells, and neural adaptations that enhance nerve-muscle interaction. Muscle cells subjected to regular bouts of exercise followed by periods of rest with sufficient dietary protein undergo hypertrophy as a response to the stress of training. Enhanced muscle protein synthesis and incorporation of these proteins into cells cause hypertrophy. Because there are more potential power strokes associated with increased actin and myosin concentrations, the muscle can exhibit greater strength. [17]

In the TKR surgery the quadriceps tendon, which is located above the kneecap, is typically cut and sutured back together during surgery thus patients experienced a profound loss of quadriceps strength, marked failure of voluntary muscle activation, and a decrease in quadriceps cross-sectional area. Quadriceps strength is affected more severely than other clinical measures. Quadriceps strength is an important factor to consider in the strengthening of patients with TKA. [18]

The table no. 7, represents Post hoc analysis of muscle strength of group B which states that there was significant difference pre to post-op and post-op to 4th week but no significant difference between 4th to 8th weeks and post-op to 8th weeks in muscle strength of GROUP B. This may be attributed to the nature of Pilates exercises which are performed in a controlled and slow manner leading to slower increments in muscle power.

The treatment strategy used in group B (Pilates based program) was given as per prescribe program. This is in accordance with previous study done by Levine B, Kaplanek B, Jaffe WL. Pilates training for use in rehabilitation after total hip and knee arthroplasty: a preliminary report. Clin Orthop Relat Res. 2009;467(6):1468-1475. They concluded that at 1year follow-up, review of patient charts and follow-up telephone calls revealed; 25 patients were extremely satisfied and 13 were satisfied with their outcome and use of Pilates in their

rehabilitation. [19]

The table no. 8, and graph E, indicate inter-group comparison of the results for muscle strength. Between the group during the pre-op and post-op phase there was no difference in strength due to pain and weakness. But there is significant difference for the strength after intervention in both groups given from 4th weeks to 8th weeks.

The table no. 9, represents Post hoc analysis of BBS score of group A. There no was significant difference in pre- to post-op, post-op to 4th week but significant difference between 4th to 8th weeks, there was highly significance difference found in post-op to 8th week in BBS score of group A that means there is increase in balance. The exercise protocol for group A (ERP) was given as per protocol. Using ERP exercise, it helps in building strength of legs and back, and build a stronger base to control the body and improve awareness of physical capabilities and balance.

The table no. 10, represents Post hoc analysis of BBS score of group B. There was no significant difference in pre- to post-op, but significant difference between post-op to 4th week 4th to 8th weeks, post-op to 8th weeks in BBS score of group B that conclude improvement in balance. The exercise protocol for group B(PBE) was given according to prescribe program. According to table no 9, there is significant improvement in balance. This is in accordance with the previous study done by Aysenur Karaman, Inci Yuksel, Gizem Irem Kinkili. Do Pilates- based exercises following total knee arthroplasty improve postural control and quality of life? International Journal of Physical Therapy, 2017;(4):99-102. The study results were when compared the differences between pre- and post-treatment balance scores of the groups, they found a significant change in favour of the Pilates-based exercise group. They concluded that Pilates-based exercises performed along with standard exercise programs were more effective for improving balance and quality of life than standard exercise programs alone. [17]

"Movement heals the body both physically and mentally, The Pilates method improves stamina, coordination, strength and mobility, and helps to rejuvenate the body. [14]

The table No. 11 and Graph F indicate inter-group comparison of the results BBS scale. There is significant improvement in balance after intervention given at pre-op and post-op in both the groups. But there is no significant difference in balance after intervention in both the groups from 4th week to 8th week. Hence, we can say both the protocols are beneficial for improvement in balance.

The table no. 12, represents Post hoc analysis of LKS score of groups A. There was no significant difference in pre- to post-op but significant difference was found between, post-op to 4th week, 4th to 8th week and post-op to 8th weeks in Lysholm knee scale score of group A. Thus, showing improvement in functional ability of the patients. This is in accordance with previous study done by Hong-hui Jiang, Xiao-fei Jian et al Effects of Enhanced Recovery After Surgery in Total Knee Arthroplasty for Patients Older Than 65 Years. Orthopedic surgery published by Chinese orthopedic association and john Wiley &sons Australia 14 October 2018; (24 February 2019); 11:229–235. They concluded that this multimodal rehabilitation program includes pre-operative patient education, followed post-operatively by early nutritional supplementation, early mobilization, patients showed significant improvements in pain, stiffness, and functional stability. [13]

The table no. 13, represents Post hoc analysis of LKS score of groups B There was no significant difference in pre- to post-op, post-op to 4th week, 4th to 8th weeks but significant difference between, post-op to 8th week in Lysholm scale score of group B. Thus, showing improvement in functional ability. As Pilates increase the flexibility, strength, and stamina, the knee functions improved, there was decrease in pain and improvement in strength and balance. The result of present study is in accordance to the study A research article published in 8th International congress on physical education and sports sciences Feb.19-20, 2015 by Jafari, Mehdi 1, Ghasemi, Gholam Ali titled as "Effects of Pilates exercise on pain of Patients with total knee replacement". The aim of study was to assess the effect of 8 weeks of Pilates exercises on pain, outcomes, and quality of life of female patients with total knee replacement. The result shows no significant difference between two groups regarding pain symptoms. ADL, sports and recreational activities and QOL before the intervention. But study concluded that Pilates exercise can be helpful as complementary techniques alongside medication and conventional therapy for TKR. [14]

From table no. 14, and graph E, indicate inter-group comparison of the results for LKS score. There is highly significant improvement in functional activity after intervention pre-op and post-op. But there is no significant difference for the LKS score after intervention in both groups given from 4th to 8th week and post-op to 8th week. Thus, the results show that the functional ability in both the groups has improved.

The statistical results are showing overall equal benefits of the ERP and Pilates groups although for range of motion and balance was more significantly improved in enhanced recovery program exercise. Muscle strength and functional ability of patients were more improved by Pilates based exercise.

Conclusions

The goal of this study was to help the patient to return to the highest level of function, while improving the overall quality of life physically, emotionally, and socially. The focus of rehabilitation was on relieving pain, restoring normal joint mobility, strengthening of core muscle groups, postural retraining. [20]

The findings of this study also give rise to important clinical implications about treatment of patients with TKR, Patients with TKR may benefit from modern therapeutic approaches such as ERP and PBE. Enhanced Recovery based program includes patient/family education and reduced length of stay due to which patient return to home earlier that help psychologically.

Pilates based exercise benefits patient with better posture and core stability, improve range of joint motion and muscle strength, movement pattern restoration. better breathing control, enhanced muscle control and coordination.

Within 8th weeks of treatment, in this study results showed highly significant improvement in all outcome measures (ROM, MMT, BBS SCORE, LYSHOLM KNEE SCALE score) for both the groups. The conclusions of the current study that there was significant improvement in all the aspects and reduction of pain with the use of enhanced

recovery program and Pilates based exercise.

Limitations:

- The study was conducted for a limited duration therefore long-term effect could not be studied.
- The small sample size in the treatment group may preclude conclusions on dose–effect relationship of exercise and therefore it cannot be generalized.
- Because of pandemic (COVID-19), some session had taken through tele rehab, and to explain the patient the breathing pattern and position of exercise was difficulty that might also affect the result.

Recommendations:

- Alternately along with enhanced recovery program, Pilates based exercise program electrical modalities technique may be incorporated.
- Long term effectiveness of Pilates based exercise should be tested.

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