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Effectiveness of Kinetic Control Exercises Over Traditional Exercises in Restoring Balance, Gait and Functional Independence after Total Hip Replacement - A Comparative Study

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Abstract: ***Osteoarthritis (OA) is a degenerative disorder characterized by loss of articular cartilage, hypertrophy of bones at articular margins, subchondral sclerosis, changes in synovial membrane & joint capsule. As OA hip worsens, mechanical dysfunction develops between local and global musculature of hip joint. Impingement and rotational strain dysfunction aggravate the mechanical dysfunction in hip joint worsening the OA hip. Total hip arthroplasty (THA) is a surgical procedure where articular surfaces of the joint are replaced with artificial prosthesis. The mechanical dysfunction still persisted in patients who underwent THA. This mechanical dysfunction lead, to development of uncontrolled movements (UCM) in hip joint post THA. Movements to show UCM in operated hip were extension, abduction and external rotation. The presence of UCM affected balance, gait and functional independence in these subjects. Present study focussed on effectiveness of kinetic control exercises over traditional exercises in restoring balance, gait and functional independence after THA. The data was collected and analysed accordingly using appropriate statistical tests. We conclude that both traditional hip exercises and kinetic control exercises were found equally effective in restoring balance & functional independence for both groups. Gait parameters like stride, step length, cadence & TUG scores were significantly improved for experimental group.***

Keywords: Osteoarthritis (OA), Total hip arthroplasty (THA), Mechanical dysfunction, Uncontrolled movements (UCM), Kinetic control

1. Introduction

Osteoarthritis (OA) is a degenerative disorder of multifactorial nature. It is characterised by loss of articular cartilage, hypertrophy of bones at margins, subchondral sclerosis, changes in synovial membrane and joint capsule(1). We observe 2 types of OA, primary and secondary OA. Primary OA doesn't have any specific cause and comes with ageing but the secondary OA has one particular cause. In India the prevalence of OA is 22% to 39% and is mostly seen in females than in males. Radiological changes regarding OA are seen in 70% of women above 65 years of age. Among non-fatal burden OA is the 10th leading cause(2).

OA can be treated by pharmacological and non-pharmacological methods. Under pharmacological methods we have NSAID's to relive the pain inflammation. In the initial stages OA hip, patients who are obese are suggested to undergo weight reduction followed by proper orthotic bracing and use of NSAID's (3). Exercise therapy as a non-pharmacological treatment method helps in relieving pain which NSAID's do as much and 2 to 3 times as large effective as acetaminophen do(4). Exercise therapy remains as a good treatment option for controlling pain and improving functions in patients with hip OA. It also helps in preventing at least 35 chronic conditions from occurring and improve symptoms in at least 26 chronic conditions. The exercise therapy protocol should be specific to patient with adequate dosage to get good clinical effects. According to literature manual therapy along with exercise therapy was effective and superior to only exercise therapy program to treat hip OA (5).

Land based exercise programs are effective in reducing pain and improve function in patients with hip OA. Aqua therapy can be a good alternative for the patients who can do land-based exercise program(5). Treatment options for hip OA include acupuncture in which very thin needles are inserted inside patient's body at specific points to relieve pain. The results are not (6). Tai chi and yoga were also found to be effective in patients with hip OA as they were safe and easy to do. Self-care measures explained to patients had a positive effect over their quality of life (7). Cognitive behavioural therapy was found to be beneficial in cases where there was severe depression due to pain (4). Neuromuscular training, such as neuromuscular exercise program (NMEX) was found to be feasible, well tolerated and effective in reducing pain, improving functions in patients with hip and knee OA (8).

Sahrmann and Lee said that clinical reasoning process is required to differentiate between groin, trochanteric and buttock pain arising from hip and pain arising from lumbar spine and sacroiliac joint (9). Radiological findings in hip OA sometimes misleads the patient's during the exercise

program (5). The initial management by the clinician doesn't change much according to radiological presentation (10).

After failure of conservative management total hip arthroplasty (THA)/total hip replacement (THR) is done (11). It is a surgical procedure where the articular surfaces of the hip joint are replaced by artificial prosthesis. Studies done by sir John Charnley laid the foundations for development of solution for hip OA in a surgical way. He used artificial models which were designed based upon the biomechanics of human hip joint. The first THA was done by Phillip wiles from London in the year 1938 which was further developed Mckee and Farrar in the year 1950 (1). Indications include primary OA, rheumatoid arthritis, trauma, ankylosing spondylitis, avascular necrosis of hip (AVN) (11). Among the approaches to do THA we have posterior, direct lateral, direct anterior, anterolateral, trans trochanteric, superior gluteal and Watson jones approach (12). No approach was superior to another and each had there, own merits and demerits. Minimally invasive intermuscular approaches were found to be non-superior to conventional approaches in THA (13).

The prosthesis used in THR are generally made up of metals, ceramics, and plastic materials. Also, titanium alloys stainless steel, special high strength alloys, alumina, zirconia toughened alumina (ZTA) and UHMWPE which is also known as polyetheretherketone (PEEK) are used. The acetabular component is made up of high molecular weight polyethylene (14). In cemented arthroplasty the prosthesis is firmly attached to the bone with the help of polymethylmethacrylate cement. In uncemented arthroplasty, the implants firmly get attached to bone with the help of bony ingrowth into the porous femoral stem leading to biological fixation (1).

After THR there was failure of restoration of hip joint kinetics. Decreased hip extension, external rotation moments and hip power generation was noted (15). Gait abnormalities like decreased stride length and step length was noted even after one year in patients who underwent THR. Due to excessive anterior tilting of the pelvis, it affected the hip extension which in-turn led to weakness of hip extensor muscles. Hence strengthening of hip extensor muscles is necessary in patients who underwent THR (16). Balance is important for physical function and mobility. Lack of balance makes an individual prone to falls. Balance training is important and should be added in the rehab program to improve the balance and functional mobility. When patients who underwent total knee replacement (TKR) underwent balance training showed good improvement than patients who underwent THR (17). Pre operative rehab program mainly concentrating over hip abductors, flexors along with stretching of medial and anterior structures helped in proper loading of the hip joint post operatively (18).

A movement is said to be optimal when functional tasks and postural control are easy to perform in an efficient way which minimizes physiological stress and also control it. The movement system in the body consists of coordinated interaction between articular, myofascial, neural, connective tissue system and psychosocial influences. Disturbance in movement system can cause uncontrolled movement (UCM) or movement system dysfunction. Sahrmann said that faulty movement can lead to pathology and vice-versa. Musculoskeletal pain syndrome caused by isolated events and habitual movements; sustained postures play an important role in the development of movement dysfunction (9). It is important to identify UCM in the functional movement system. The direction of UCM shows the direction of stress or strain and pain producing movements. The UCM identifies the site and direction of dynamic stability dysfunction, also identifies the direction of symptom producing movements. UCM keeps an abnormal stress or strain on various tissues which leads to pain and pathology, also vice-versa.

Symptoms, dysfunction, disability, recurrence, risk and performance are the factors which affect the site and direction of UCM. Bergmark, designed a model to describe how load transfers in the lumbar spine. He introduced the concept of local and global muscle system. The local muscle system increases the segmental stiffness and decreases the intersegmental motion. The global muscle system is responsible for production and control of range and direction movement (19). Sahrmann propped a concept of relative flexibility or relative stiffness. According to this concept when one joint muscle becomes lengthened, strained or become weak they lack the ability to shorten adequately and show increased flexibility. This flexibility contributes to UCM at the joint. In case of multi-joint muscles, if they lack extensibility or generate excessive tension than it leads to stiffness in the muscle. This stiffness restricts the motion at the joint which they primarily move. This defect is compensated elsewhere in the movement system. If the muscles are connected in the functional movement system, then UCM produced at one joint is not controlled by the one joint muscle relative to adjacent restriction (9).

When relatively flexible structures compensate for relatively stiffer structures in function then direction specific stress and strain occur leading to hypermobility. It causes repetitive loading and tissue pathology (20). Luomajoki says fault in movement control indicate lack of control on active movements and termed it as movement control dysfunction (MCD). It is identified by a series of tests and they have found it to be reliable in lumbar spine problems (21,22). These tests are based upon the concept of dissociation which is defined as the inability to control movement in one segment of the movement chain while concurrently producing active movements at another joint of the movement chain. A dissociation test actively evaluates the ability to actively control the movement (9,20). The identification of UCM should be made according to site and direction based on the ability to cognitively control the movement but by observing the altered way of motion (9, 21, 23).

The development of UCM have many contributing factors like compensation for restricted movement to maintain optimal movement, direct over facilitation, sustained passive postural positions and trauma. Arokoski said that subjects with hip OA developed decreased strength in abduction by 31% compared to control group. They also demonstrated 13% decrease in cross-sectional area of the gluteal and adductor muscles of the more severely affected hip as compared to normal hip. But there were no strength deficits

interestingly (24). Robinson et al in their series of 8 case reports said that subjects with hip pain presented with decreased cross-sectional area of piriformis, gemelli inferior, obturator externus (25). Grimaldi et al in their study checked for changes in gluteus maximus and tensor facia latae in subjects with unilateral hip pain ranging from labral pathology to advanced OA by MRI (magnetic resonance imagining). They found that gluteus maximus muscle had two compartments. They were superficial and deep muscle compartments. They concluded that in patients with hip OA the lower compartment of gluteus maximus showed decreased volume in relation to pain and OA severity while superficial part which inserted into tensor facia latae (TFL) to form iliotibial band showed no difference in volume. Hence strength deficits assessment may not rule out hip dysfunction (26).

Mechanical dysfunction in hip joint commonly present as combination of impingement, instability and rotational strain dysfunction all which can lead to degenerative changes in hip joint leading to hip OA. The dysfunction within global and local musculature of the hip joint causes insidious onset, chronicity and recurrence of hip pain. When they arise from the regional tissues mechanical dysfunction and altered muscle recruitment patterns are evident. They present as motor control inhibition of muscle function and motor imbalance.

The direction of UCM in hip joint are flexion, extension, abduction/lateral rotation, adduction and forward glide. Since patients suffering with hip OA for long period time are under conservative management, they develop imbalance between local and global muscle system. this leads to UCM. The main movements affected for hip OA patients are extension, abduction/lateral rotation and adduction. These movements are useful for functional activities in daily living. Hence a therapist should assess for these movement dysfunctions for affective treatment. These dysfunctions are present even after total hip arthroplasty (THA) due to which the gait, balance, functional independence is affected. Each movement has specific tests to assess for dysfunction and UCM. Treatment is given accordingly.

There comes the kinetic control concept which is the revised version of many theories explained above and is found to be useful in treating the muscle dysfunction. Hence the study conducted is concerned to check whether the traditional exercises or kinetic control exercises are effective in quicker restoration of balance, gait and functional independence in patients after total hip arthroplasty (THA). Only prospective cases which came for partial weight bearing after total hip arthroplasty (THA) were included into the study.

2. Review of Literature

(Gasparuto et al., 2021) In their study said that people who undergo total hip arthroplasty (THA) attain only 80% of functional independence. Hence the therapist should understand which functional tasks are being affected. Time up and go test (TUG) helps in analyzing functional movements in daily activities and also guides the therapist to create a rehab program to address these deficits in functional movements. According to them creating a rehab program according TUG test deficits will improve functional movements and hence becomes an indicator for improvement in balance and functional independence (27).

(Ding et al., 2018) In their study said that patients undergoing total hip arthroplasty as a treatment for ankylosing spondylitis, the Barthel index and Harris hip scores showed significant difference post operatively when compared to pre-operatively in both fusion and non-fusion groups. But there was no significant difference between Harris hip scores and Barthel index for both the groups post operatively (28).

(**Bennett et al., 2017**) In their study said that after THR there is failure of restoration of hip joint kinetics like hip extension and external rotation moments and hip power generation. Gait abnormalities persisted for one year after surgery in patients who underwent THR. Hence effective rehab is necessary (15).

(Colgan et al., 2016) In their study said that in patients after one year of THR, there were gait abnormalities noted. There was decrease in stride and step length. There was decrease in hipextensor muscle strength due to excessive anterior tilting of the pelvis. This led to gait abnormalities (16).

(Jogi et al., 2015) In their study said that balance training is an important part of rehab in patients undergone TKR and THR. Exercises were made to do by patients for 5 weeks post operatively. The balance was studied by four outcome measures like TUG test, WOMAC index, Berg balance scale, activities specific balance confidence scale. There was significant improvement in balance (17).

(Lomabardi et al., 2014) In their study said that patients undergoing total hip arthroplasty as a treatment for neck of femur fractures and OA hip showed significant improvement in Barthel index scores, and passive ROM of flexion and abduction. But the hospital stay was more for hip fracture group than OA group. The passive ROM of OA group was less than the hip fracture group (29).

(**Coulter et al., 2013)** In their study said that physiotherapy helps in improving hip abductor strength, gait speed and cadence. Exercises which were done under the supervision of a physiotherapist and at home were found to be equally effective (30).

(Lenaerts et al., 2009) In their study that pre operative physiotherapy exercises mainly concentrating over hip abductors and flexors along with stretching of medial and anterior structures help in proper loading of the hip joint post operatively (18).

(Grimaldi et al., 2009) In their study checked for changes in gluteus maximus and tensor fascia latae in subjects with unilateral hip pain ranging from labral pathology to advanced OA by magnet resonance imagining (MRI). They found that the gluteus maximus muscle has 2 muscle compartments. One is the superficial part and the second one is deeper part (26).

(Foucher et al., 2007) In their study said that preoperatively there was decrease in all peak external moments and dynamic

hip rom. Post operatively there was decrease in peak internal and adduction moments. Hence even though there was restoration of hip rom after surgery gait abnormalities still persisted for one year after surgery (31).

(Robinson et al., 2005) In their series of 8 case reports said that subjects with hip pain presented with decrease in cross sectional area of piriformis, gemelli inferior, obturator externus or combination of one or more of these muscles (25).

(Sahrmann, 2002) says that faulty movement can lead to pathology and also pathology can cause faulty movement. Also musculoskeletal pain syndromes caused by isolated events and habitual movements, sustained postures play a major role in development of movement dysfunction (9).
(Arokoski et al., 2002) In their study said that subjects with hip osteoarthritis developed decreased strength in abduction by 31% compared to control group. They also demonstrated 13% decrease in the cross-sectional area of the gluteals and adductors on the more severely affected hip as compared to better hip. But there were no strength deficits interestingly (24).

(Rosler and Perka., 2000) In their study said that prothesis used in THR should be proper and aligned properly. Cranialization of femoral stem leads to decrease in the movements of hip and knee joints whereas caudalisation of femoral stem leads to proper movements of hip and knee joints (32).

(Bergmark, 1989) designed a model to describe how load transfers in lumbar spine. He introduced the concept of local and global muscle system. The local muscle system increases the segmental stiffness across a joint and decreases intersegmental motion. The global muscle system is responsible for production and control of range and direction of movement (19).

3. Methods and Approach

- **Study Setting:** The study was conducted in Department of physiotherapy and Department of Orthopaedics, Nizam's Institute of medical sciences, Hyderabad, Telangana.
- **Study Type:** A comparative study.
- **Study Duration:** 6 months.
- **Sampling Strategy:** Simple Random Sampling was used.
- **Sample Size:** 26. G power software was used to calculate the sample size.

Materials Used

1) Examination table and chair, to examine and treat the patient.
2) Notepad
3) Measuring tape
4) Goniometer
5) Stop watch.

Study Procedure

A total of 26 subjects were included into the study after they satisfied the eligibility and inclusion criteria. These subjects were patients who underwent total hip arthroplasty (THA) as a treatment for OA hip. Only unilateral THR subjects were taken into the study from orthopaedic department, Nizam's institute of medical sciences. The subjects who were willing to participate into the study were requested to read the patients information sheet and sign the informed consent form approved by the institutional ethics committee. NIMS INSTITUTIONAL ETHICS COMMITTEE review letter number: EC/NIMS/2986/2022, 60 th ESGS NO.1343/2022. The subjects were randomly allocated into 2 groups using simple random sampling method. One group was control and another group was experimental. Each group had 13 subjects each. There was no communication between groups. The subjects were assessed for balance, gait, and functional independence when they came for partial weight bearing at department of physiotherapy. These were noted down on the day of initiation of rehabilitation and were noted down after each month of rehabilitation. This was done for 3 months. Also there TUG test and Barthel index scores were noted down to check for the mobility and performance in activities of daily living respectively on the day of initiation of rehabilitation and after every month of rehabilitation. This was done for 3 months.

Inclusion Criteria:

- Patients having lack of hip extension, abduction, and adduction movementcontrol due to undergoing THR as treatment for osteoarthritis.
- Age group included is 30 to 70.

Exclusion Criteria:

- Osteomyelitis.
- Non healing neck of femur fractures.
- Malunion and delayed union of neck of femur fractures.
- Fracture dislocations of head of femur damaging acetabulum.
- Neuropathic joints.
- Fractures of neck of femur treated with DHS, cortical and cancellous screws.
- Tumours of pelvis.
- Patients of age above 70 years.
- Patients who have undergone bilateral THR.
- Patients who have undergone hip hemiarthroplasty.
- Patients who are deemed to be unfit for physiotherapy study procedure will be excluded by investigator discretion.

Informed Consent:

Subjects were randomly assigned into 2 groups. The subjects willing to participate in the study are requested to read the patients information sheet and sign the informed consent form which was approved by the institutional ethics committee of Nizam's institute of medical sciences. NIMS INSTITUTIONAL ETHICS COMMITTEE review letter number: EC/NIMS/2986/2022, 60th ESGS NO.1343/2022. They were explained about the intervention that was going to be given and requested their persistence and co-operation during the study.

Outcome Measures:

Balance: Balance of the patients were measured by using berg balance scale (BBS).

GAIT Parameters:

- Stride length, step length and cadence will be measured for the subjects enrolled into the study.
- Stride length is the distance between heel strike of one extremity to next heel strike of the same extremity. It was measured in centimetres.
- Step length is the distance between heel strike of one extremity and heel strike of opposite extremity. It was measured in centimetres.
- Cadence is the number of steps taken by the subjects in one minute.

Activity Specific Balance Confidence Scale:

Functional independence was measured by activity specific balance confidence scale.

Time Up and Go Test (TUG TEST):

The mobility of the subjects was measured by time up and go test. And were gradedaccordingly.

Physiotherapy Treatment Protocol:

The control group will do traditional hip rom exercises and balance exercises. The experimental group will do kinetic control exercises and balance exercises. For, the experimental group we have three defects to check about.

1) Lack of extension control.
2) Lack of abduction control.
3) Lack of adduction control.

This lack of control is due to weakness in the respective musculature. This is checked by the following.

Hip extension by:

1) Thoracolumbar extension test.
2) Standing single knee lift + anterior tilt test

Hip abduction by: 1) bridge: single leg lift test.

Hip adduction by: 1) lateral pelvic shift test.

- After assessment done by investigator through these tests patients will be assigned under the specific defect accordingly.
- Exercises for improving kinetic control will be given to patients with specific defect accordingly.

Exercises for control group include the following (each exercise 10 reps x 3 x 3times a day):

1) Static quadriceps exercise.
2) Static hamstrings exercise.
3) Knee AROM exercises in sitting and standing.
4) Hip AROM exercises in standing and supine.
5) Gluteal isometric exercise.
6) Abdominal core strengthening exercises (which includes pelvic bridging).
7) Stretches for iliopsoas and hip adductor muscles.

Balance exercises for control group (each exercise 10 reps x 3 x 3 times a day):

1) Rotate trunk clockwise and then in anti-clockwise direction in standing without support.
2) Lunge in walk standing position without support and then repeat with the other leg forward.
3) Shift weight to one side in a stride standing position without support and then.Repeat on the other side.
4) Sit to stand and stand to sit.
5) Walking forwards on lines drawn on floor one feet apart.

- **Exercises for experimental group (each exercise 10 reps x 3 x 3 times a day):**
- Kinetic control exercises which are specific for specific defect.

For hip extension:

1) Patient stands tall and unsupported with legs straight and the spine, pelvis and hips positioned in theneutral. Without, causing the hips to move into extension or forward sway of pelvis, the patient actively lifts the chest up into thoracolumbar extension until the forward sway of pelvis or extension of hip can be controlled. The normal anterior pelvic tilt should be maintained and all the lumbar spine and lower thoracic vertebrae should contribute to spinal extension. In case control is poor then support is added. The patient stands in front of a bench or table with feet under the table so that balance can be maintained. The table prevents hip extension and forward sway of the pelvis, the chest should move upwards leading to thoracolumbar spine extension. Progression is done by removing the support and implementing these exercises in functional activities like standing.

2) In another test method the patient stands upright and feet apart. The patient shifts weight over onelimb and tries to lift the opposite one above the ground. By flexing the hip to 90 degrees, the patient tries to extend the knee. If the control is poor, then the hip is held below 90 degrees of flexion. The lumbar lordosis should be maintained. If required the patient can take the support of the wall. By maintaining that position, knee should be extended. It should be done until the thigh position is maintained. If the thigh goes into flexion, then the movement should be stopped and patient should hold the position and come to neutral position. Repeat the same and continue till the patient can extend the knee completely when the hip is flexed at 90 degrees.

For hip abduction:

During the bridge, single lift test, the hip adductors and rotator stabilizers are not able to effectivelycontrol the hip from going into hip abduction. Patients lies in crook lying position with feet together the patient will lift the pelvis 5cm above thecouch while maintaining neutral alignment. Taking weight over one foot, the patient will extend the knee of the unweighted lower limb. While doing knee extension at some point if the hip is going into abduction, (10) then the movement is corrected and position is hold for few seconds (5) and patient comes back to normal position. Once, control develops progression is done by extending the knee completely.

For hip adduction:

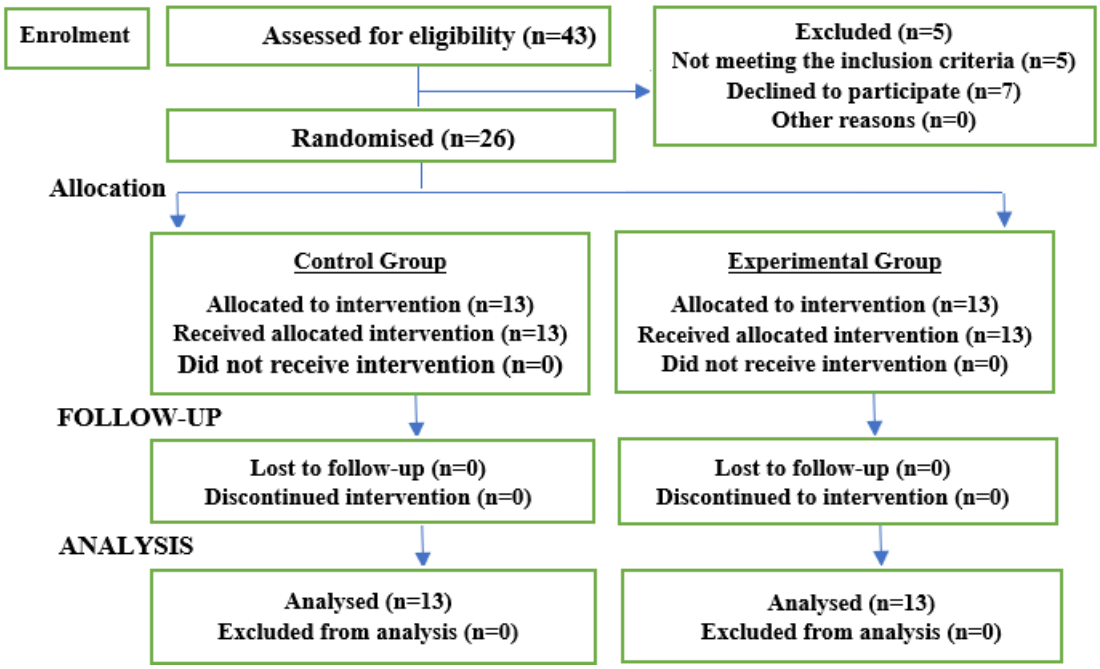
Patient is asked to stand against the wall. The feet at least 5-10cm away from wall. The pelvisshould be level and trunk upright. The patient should shift the weight over one limb and shift the pelvis laterally towards weightbearing limb with synchrony of shoulders. Shift full weight over one limb and try to lift the other limb up. There should be no excess hipadduction on weight bearing limb. If any fault is observed, it is corrected and patient is asked to hold for few seconds (5) and patientcomes back to normal.

Balance exercises for experimental group (each exercise 10 reps x 3 x 3 times a day):

1) Rotate trunk clockwise and then in anti-clockwise direction in standing without support.
2) Lunge in walk standing position without support and then repeat with the other leg forward
3) Shift weight to one side in a stride standing position without support and then. Repeat on the otherside.
4) Sit to stand and stand to sit.
5) Walking forwards on lines drawn on floor one feet apart.

- Exercises will be done by patients of both the groups twice in a day, every week. They will be assessed periodically and results will be interpreted. Balance and mobility will be tested by TUG test, and measured by Berg balance scale.
- Functional independence will be measured by Activities specific Balance confidence scale.
- Gait parameters like cadence, stride length, step length will be recorded timely every month.
- Effect of exercises on performance in activities of daily living will be measured by Barthel index.
- Through telephonic conversations patient's adherence to exercises will be observed and noted.
- The exercises mentioned above will be done by subjects of both the groups for 12 weeks daily.

Flow Chart of Study Methodology



4. Results and Discussion

Statistical Analysis

- 26 subjects were allocated into 2 groups A and B with 13 subjects each. Group A is control and Group B is experimental. Simple random sampling method was used. Thorough examination of the subjects was done basedon criteria in methodology.
- The following parameters were taken during the course of the study "EFFECTIVENESS OF KINETIC CONTROL EXERCISES OVER TRADITIONAL EXERCISES IN IMPROVING BALANCE, GAIT AND FUNCTIONAL INDEPENDENCE AFTER TOTAL HIP REPLACEMENT – A COMPARATIVE STUDY."
- Balance was measured by Berg balance scale (BBS).
- Functional independence was measured by activity specific balance confidence scale (ASBCS)
- Improvement in performing activities of daily living (ADL'S) was measured by Barthel Index (BI).
- Gait parameters like stride length, step length, cadence was, measured by Inch tape and stop watch.
- The improvement in physical mobility was measured by time up and go test (TUG).
- The data was collected from the subjects who underwent total hip replacement (THR) on the day when they came to physiotherapy department for partial weight bearing. After clearance from the clinician for gait training with walker support via partial weight bearing the data was collected.
- Data again was collected after 1st, 2nd, and 3rd month of rehabilitation and the following above mentioned outcome measures were recorded periodically.
- The data was descriptively analysed first. The continuous variables were expressed as Mean ± SD and median (inter quartile range).
- Categorical variables were expressed as percentage. The pre rehabilitation versus post one month, 2nd month, 3rd month data were analysed using **Wilcoxon signed Rank Test.**
- The data were analysed separately for controls and experimental groups. A two-sided "p value" less than 0.05 was considered to be statistically significant. All analysis were done by using the SPSS 21.0 version (SPSS, IL, Chicago, USA) software for Windows.

4.1 Results

- Results in the present study, which was conducted during a 6 months period, a total of 26 participants were included and assessed for eligibility criteria. The subjects who met the eligibility criteria who also satisfied the inclusion criteria were included into the study.

- The mean ± SD age was 46.15 ± 9.18 years in the control group and it was 45.46 ± 8.19 years in the experimental group. There were 7 (53.8%) males and 6 (46.2%) were females participated in the control groupand there were 9 (69.2%) males and 4 (30.8%) females participated in the experimental group. The differenceof age and gender not significant between control and experimental group (p>0.05).
- The BBS was significantly increased from pre rehabilitation to post rehabilitation at one month, two months andthree months in both control and experimental groups (p<0.01 for all) (Table 1).

Table 1: Pre versus post rehab comparison of BBS in control and experimental groups

Group	Sample size	BBS pre Median (IQR)	BBS 1st month Median (IQR)	p	BBS 2nd month Median (IQR)	p	BBS 3rd month Median (IQR)	p
Control	13	44 (38, 49.5)	55 (52, 56)	0.001	56 (56, 56)	0.001	56 (56, 56)	0.001
Experiment	13	49 (38, 52.5)	55 (53, 56)	0.002	56 (56, 56)	0.003	56 (56, 56)	0.001

The BI was significantly increased from pre rehabilitation to post rehabilitation at one month, two months andthree months in both control and experimental groups (p<0.01 for all)

Table 2: Pre versus post rehab comparison of BI in control and experimental groups.

Group	Sample size	BI pre Median (IQR)	BI 1st month Median (IQR)	p	BI 2nd month Median (IQR)	p	BI 3rd month Median (IQR)	p
Control	13	60 (50, 90)	100 (95, 100)	0.002	100 (100, 100)	0.001	100 (100, 100)	0.001
Experiment	13	65 (62.5, 80)	100 (95, 100)	0.002	100 (100, 100)	0.002	100 (100, 100)	0.002

The ASBCS percent also increased significantly from zero at pre rehabilitation to post rehabilitation at onemonth, two months and three months in both control and experimental groups (p<0.01 for all) (Table 3).

Table 3: Pre versus post rehab comparison of ASBCS in control and experimental groups

Group	Sample size	ASBCS pre Median (IQR)	ASBCS 1st month Median (IQR)	p	ASBCS 2nd month Median (IQR)	p	ASBCS 3rd month Median (IQR)	p
Control	13	0 (0, 0)	69 (58.5, 81)	0.001	81 (76.5, 94)	0.001	94 (87.5, 94)	0.001
Experiment	13	0 (0, 0)	69 (59, 81)	0.001	94 (81, 94)	0.001	94 (94, 94)	<0.001

The STRL also increased significantly from pre rehabilitation to post rehabilitation at one month, two months and three months in both control and experimental groups (p<0.01 for all) (Table 4). However, the stride lengthof experimental group got good improvement when compared to control group at the end of study.

Group	Sample size	STRL pre Median (IQR)	STRL 1st month Median (IQR)	p	STRL 2nd month Median (IQR)	p	STRL 3rd month Median (IQR)	p
Control	13	41 (30.5, 50.5)	50 (45, 67)	0.019	59 (52, 68.5)	0.005	60 (52.5, 77.0)	0.004
Experiment	13	41 (27.5, 67)	72 (50, 80.5)	0.009	74 (65, 85)	0.006	90 (80.5, 100)	0.003

The STPL also increased significantly from pre rehabilitation to post rehabilitation at one month, two months and three months in both control and experimental groups (p<0.05 for all) (Table 5). However, the step length ofexperimental group got good improvement when compared to control group at the end of study.

Table 5: Pre versus post rehab comparison of STPL in centimeters in control and experimental groups

Group	Sample size	STPL pre Median (IQR)	STPL 1st month Median (IQR)	p	STPL 2nd month Median (IQR)	p	STPL 3rd month Median (IQR)	p
Control	13	31 (28.5, 39)	41 (35, 55)	0.011	42 (39.5, 51)	0.012	42 (41, 47)	0.005
Experiment	13	37 (30.5, 42.5)	45 (38.5, 57.5)	0.012	60 (49.5, 75)	0.002	70 (46, 82.5)	0.001

The CAD also significantly increased from pre rehabilitation to post one month, two months and three months inboth control and experimental groups (p<0.01 for all) (Table 6). However, the cadence of control group got good improvement when compared to experimental group at the end of study.

Table 6: Pre versus post rehab comparison of CAD in control and experimental groups.

Group	Sample size	CAD pre Median (IQR)	CAD 1st month Median (IQR)	p	CAD 2nd month Median (IQR)	p	CAD 3rd month Median (IQR)	p
Control	13	46 (34.5, 79.5)	80 (54, 105.5)	0.001	110 (89.5, 121)	0.001	121 (94, 127.5)	0.001
Experiment	13	52 (36.5, 82.5)	85 (58, 109.5)	0.001	100 (82.5, 119.5)	0.001	120 (115, 125)	0.001

The TUG in seconds significantly decreased from pre rehabilitation to post rehabilitation at one month, two months and three months in both control and experimental groups (p<0.01 for all) (Table 7). However, the timetaken by the subjects of experimental group was less than the subjects of control group at the end of the study.

Group	Sample size	TUG pre Median (IQR)	TUG 1st month Median (IQR)	p	TUG 2nd month Median (IQR)	p	TUG 3rd month Median (IQR)	p
Control	13	44 (16, 90)	20 (10, 30)	0.001	10(9.5, 15.0)	0.001	9(9, 10)	0.001
Experiment	13	40 (18.5, 60.0)	18 (12.5, 25.2)	0.003	10(7.5, 11.0)	0.001	7(7, 9.5)	0.001

Table 7: Pre versus post rehab comparison of TUG in seconds in control and experimental groups.

Group	Mean Age
Control	46.15
Experimental	45.46

Table No: 1, this table shows the mean age of thesubjects in both control and experimental group.

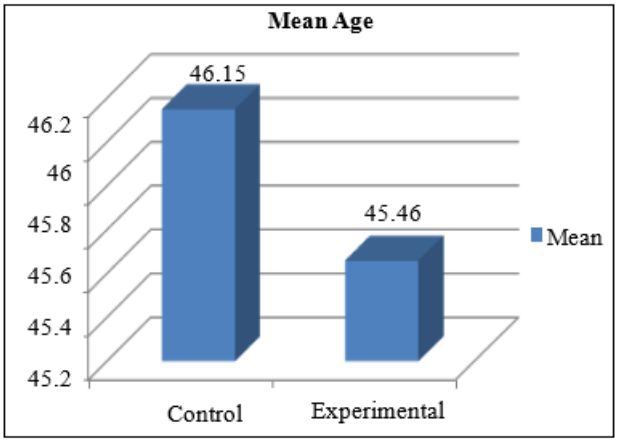


Figure 1

This bar diagram shows the mean age of subjects in both control and experimental group with mean of 46.15 for control and 45.46 for experimental group.

Group	Male	Female
Control	53.8	46.2
Experimental	69.2	30.8

Table 2, this table shows the mean age of male and female subjects in control and experimental group.

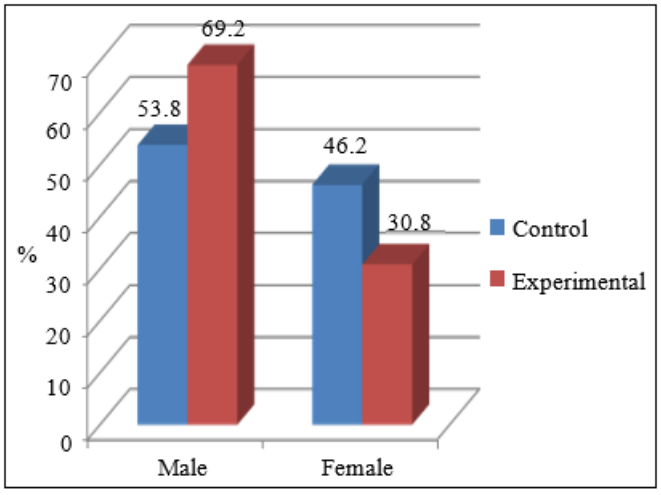
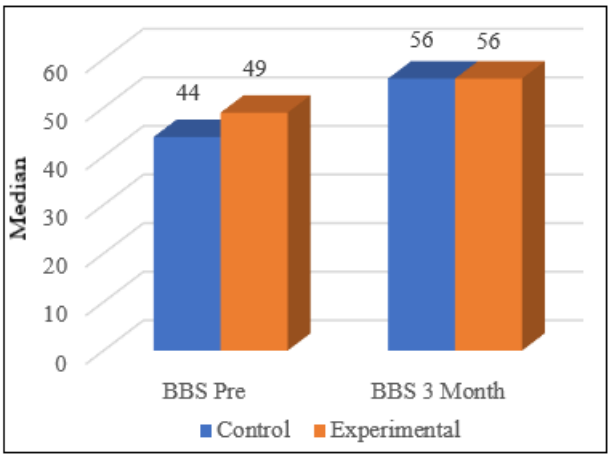


Figure 2

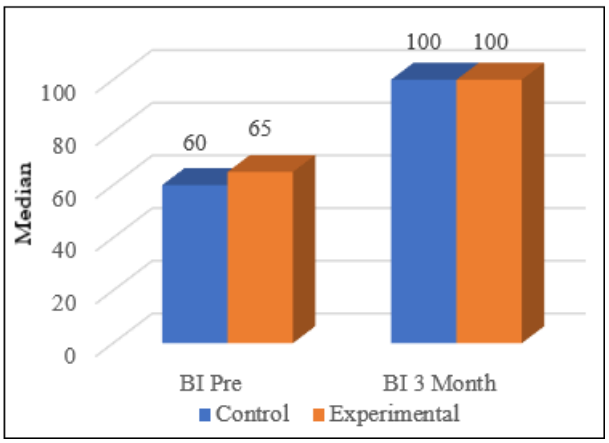
This bar diagram shows the mean age of male and female subjects in bothcontrol and experimental group. The mean of male subjects is 53.8 and female subjects is 69.2 in control group. The mean of male subjects is 46.2and female subjects is 30.8.

Group	BBS Pre	BBS 3rd Month
Control	44	56
Experimental	49	56



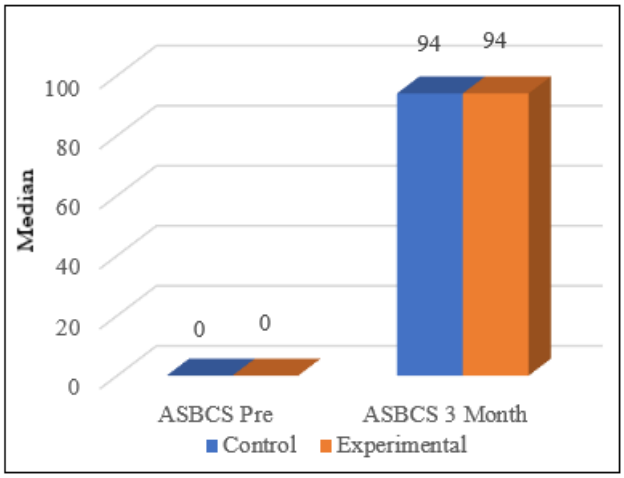
This bar diagram shows the values of balance checked via berg balance scale (BBS) pre and post treatment for both control and experimental groups.

Group	BI Pre	BI 3rd Month
Control	60	100
Experimental	65	100



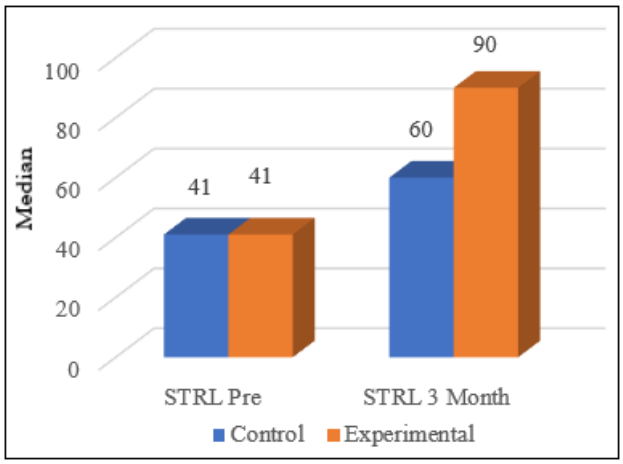
This bar diagram shows the values of Barthel index (BI) pre and post treatment for both control and experimental groups.

Group	ASBCS Pre	ASBCS 3 Month
Control	0	94
Experimental	0	94



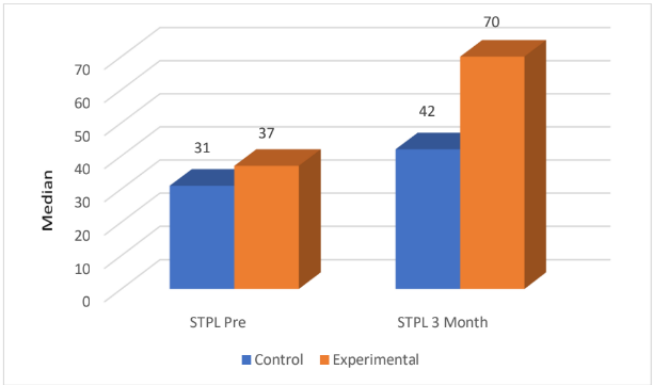
This bar diagram shows the values of functional independence pre and post treatment checked by activity specific balance confidence scale (ACBCS) for both control and experimental groups.

Group	STRL Pre	STRL 3 Month
Control	41	60
Experimental	41	90



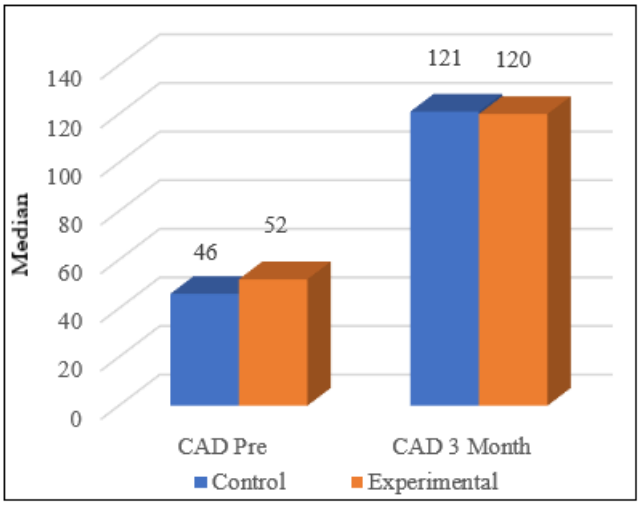
This bar diagram shows the values of Stride length checked pre and post treatment for both control and experimental groups.

Group	STPL Pre	STPL 3 Month
Control	31	42
Experimental	37	70



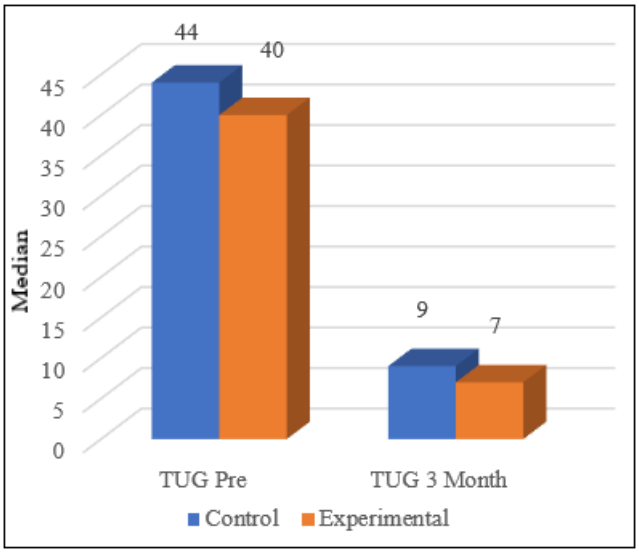
This bar diagram shows the values of Step length checked pre and post treatment for both control and experimental groups.

Group	CAD Pre	CAD 3 Month
Control	46	121
Experimental	52	120



This bar diagram shows the values of Cadance checked pre and post treatment for both control and experimental groups.

Group	TUG Pre	TUG 3 Month
Control	44	9
Experimental	40	7



This bar diagram shows the values of time up and go test (TUG) checked pre and post treatment for both control and experimental groups.

4.2 Discussion

This study was conducted to investigate the effectiveness of kinetic control exercises over traditional exercises in improving balance, gait and functional independence after total hip replacement. Clinically diagnosed patients with hip OA who underwent total hip arthroplasty (THA) were included into the study. A total 26 subjects were enrolled into

the study and were randomized into 2 groups, control and experimental containing 13 subjects each. The control group did traditional hip ROM exercises and balance exercises. The experimental group did kinetic control exercises and balance exercises. These exercises were done for 3 months by the subjects of both the groups. They were assessed periodically by the primary investigator on the day of initiation of rehabilitation and after 1st, 2nd, and 3rd month of rehabilitation for balance, gait and functional independence. Balance, was measured by Berg balance scale (BBS). Gait was assessed via their parameters like stride length (cm), step length (cm), and cadence (steps/min). Improvement in doing daily activities was measured by Barthel index (BI). Functional independence was measured by Activity specific balance confidence scale (ASBCS). Results of this comparative study show that exercises had a significant effect over both the groups. The balance of subjects of both the groups when measured on the day of initiation of rehabilitation and showed that experimental group was doing well in balance when compared to control with median scores of 44 for (control) and 49 for (experimental). These scores increased to 55 for (control) and 55 for (experimental) after one month of rehabilitation showing significant difference between 1st month of rehabilitation and on the day of initiation of rehabilitation, with no significant differences between groups. After 2nd month of rehabilitation, the scores were 56 for (control) and 56 for (experimental) reaching normalcy, with no significant difference between groups. The scores were same after 3rd month of rehabilitation, 56 for (control) and 56 for (experimental) reaching normalcy with no significant difference between groups after 2nd and 3rd month of rehabilitation, but significant difference between 3rd month of rehabilitation and on the day of initiation of rehabilitation. The p-value was 0.001 for control and experimental group. Jogi et al., said that balance training is essential part of rehabilitation for patients who underwent total hip and knee arthroplasty. After rehabilitation their study showed significant improvement in balance of their subjects (17).

The improvement in performing activities of daily living was measured by Barthel index (BI). The median scores of Barthel index (BI) of subjects of both control and experimental group were 60 for (control) and 60 for (experimental) on the day of initiation of rehabilitation. After 1st month of rehabilitation these scores came to normalcy for both the groups, 100 for (control) and 100 for (experimental) showing a significant difference. But no significant difference was present between groups. This normalcy was maintained even after 2nd and 3rd month of rehabilitation with no significant difference between groups, but significant difference between 3rd month after rehabilitation and on the day of initiation of rehabilitation. The p-value was0.001 for control group and 0.002 for experimental group. Lombardi et al., said that patients undergoing total hip arthroplasty as a treatment for neck of femur fractures and OA hip showed significant improvement in Barthel index scores, and passive ROM of flexion and abduction. But the hospital stay was more for hip fracture group than OA group. The passive ROM of OA group was less than the hip fracture group(29) . Ding et al., said that patients undergoing total hip arthroplasty as a treatment for ankylosing spondylitis, the Barthel index and Harris hip scores showed significant difference post operatively when compared to pre-operatively in both fusion and non-fusion groups. But there was no significant difference between Harris hip scores and Barthel index for both the groups post operatively (28). The improvement in confidence for doing functional activities was measured by activity specific balance confidence scale. The median of the scores of confidences on the day of initiation of rehabilitation was 0 for both (control) and (experimental) groups because they were in non-weight bearing for about 6 weeks and came to partial weight bearing on the day of initiation of rehabilitation. After 1st month of rehabilitation, the scores were 69 for (control) and 69 for (experimental). There was no significant difference between groups. After 2nd month of rehabilitation, the scores were 81 for (control) and 94 for (experimental). There was significant difference between groups. The scores of experimental groups improved when compared to control group and also there was significant difference between 2nd month of rehabilitation and on the day of initiation of rehabilitation. After 3rd month of rehabilitation, the scores for both the groups came to near-normalcy, 94 for (control) and 94 for (experimental) with no significant differences between groups, but significant difference between 3rd month of rehabilitation and on the day of initiation of rehabilitation. The p-value for control group was 0.001 and for experimental group was <0.0001.

Jogi et al., said that balance training is essential part of rehabilitation for patients who underwent total hip and knee arthroplasty. After rehabilitation their study showed significant improvement in confidence for doing functional activities in their subjects (17). In this study the gait parameters like stride length, step length and cadence were measured with inch tape and stopwatch. The median of the scores of stride length for (control) and (experimental) groups were 41 on the day of initiation of rehabilitation. After 1st month of rehabilitation, the scores were 50 for (control) and 72 for (experimental) with significant differences between groups. There was significant difference between 1st month and on the day of initiation of rehabilitation. The scores of experimental groups increased when compared to control group. After 2nd month of rehabilitation, the scores were 59 for (control) 74 for (experimental) with significant differences between groups. There was significant difference of scores between 2nd month after rehabilitation and on the day of initiation of rehabilitation for both control and experimental groups. Experimental group responded well than control group. After 3rd month of rehabilitation, the scores were 60 for (control) and 90 for (experimental) with significant difference between groups. There was significant difference between scores after 3rd of rehabilitation and on the day of initiation of rehabilitation. The p-value for control group was 0.004 and experimental was 0.003. The median of the scores of step length for both the groups on the day of initiation of rehabilitation was 31 for (control) and 37 for (experimental). There was significant difference between both the groups. After 1st month of rehabilitation, the scores were 41 for (control) and 45 for (experimental). There was significant difference between groups and also between 1st month of rehabilitation and on the day of initiation of rehabilitation. The scores of experimentalgroups improved when compared to control group. After 2nd month of rehabilitation, the scores

were 42 for (control) and 60 for (experimental). There was significant difference between scores of both the groups, and between 2nd month after rehabilitation and on the day of initiation of rehabilitation. The scores of experimental groups improved when compared to control group. After 3rd month of rehabilitation, the scores were 42 for (control) and 70 for (experimental). There was significant difference between both the groups and also between 3rd month of rehabilitation and on the day of initiation of rehabilitation. The scores of experimental groups improved when compared to control group. The p-value for control group was 0.005 and for experimental group was 0.001.

Colgan et al., said that in patients after one year of THR, there were gait abnormalities noted. There was decrease in stride and step length. There was decrease in hip extensor muscle strength due to excessive anterior tilting of the pelvis. This led to gait abnormalities (16). The median of the scores of cadences, were 46 for (control) and 52 for (experimental). There was significant difference between the scores of both the groups. After 1st month of rehabilitation, the scores were 80 for (control) and 85 for (experimental). There was significant difference between scores of both the groups and also between the scores after 1st month of rehabilitation and on the day of initiation of rehabilitation. The scores of experimental groups improved when compared to control group. After 2nd month of rehabilitation, the scores were 110 for (control) and 100 for (experimental). The scores of control groups improved when compared to experimental group with significant differences between groups and also significant difference between 2nd month after rehabilitation and on the day of initiation of rehabilitation. After 3rd month of rehabilitation, the scores were 121 for (control) and 120 for (experimental). The scores of control group improved when compared to experimental group. There was significant difference between groups and also between 3rd month of rehabilitation and on the day of initiation of rehabilitation. The p-values were 0.001 for control and experimental groups. Coulter et al., said that physiotherapy helps in improving hip abductor strength, gait speed and cadence. Exercises which were done under the supervision of a physiotherapist and at home were found to be equally effective (30). Hence homebased exercise programs can be a good alternate option for the patients living in remote areas. The median of the scores of TUG test on the day of initiation of rehabilitation were 44 for (control) and 40 for (experimental). There was significant difference between groups. After 1st month of rehabilitation, the scores were 20 for (control) and 18 for (experimental). The scores of experimental groups improved when compared to control with significant difference between groups and also between 1st month of rehabilitation and on the day of initiation of rehabilitation. After 2nd month of rehabilitation, the scores were 10 for (control) and 10 for (experimental). The scores were same for both the groups with no significant difference, but were significant between 2nd month of rehabilitation and on the day of initiation of rehabilitation. After 3rd month of rehabilitation, the scores were 9 for (control) and 7 for (experimental). The scores of experimental groups improved when compared to control group. There was significant difference between groups, and also between 3rd month of rehabilitation and on the day of initiation of rehabilitation. The p-value for control and experimental groups were 0.001. Gasparuto et al., said that people who undergo total hip arthroplasty (THA) attain only 80% of functional independence. Hence the therapist should understand which functional tasks are being affected. Time up and go test (TUG) helps in analyzing functional movements in daily activities and also guides the therapist to create a rehab program to address these deficits in functional movements. According to them creating a rehab program according TUG test deficits will improve functional movements and hence becomes an indicator for improvement in balance and functional independence (27).

Hence in this study we conclude that both traditional hip exercises and kinetic control exercises were found to be equally effective in restoring balance and functional independence in both groups but gait parameters like stride, step length, cadence and TUG scores were significantly improved for experimental group.

5. Conclusion

This study was a comparative study. All, patients after satisfying eligibility criteria were included into study. Both groups were treated with specific exercises designed for them. Both the groups showed improvement in Berg balance scores reaching normalcy after two months of rehabilitation which was maintained after 3rd month also. The Barthel index scores for both the groups came to normalcy after one month of rehabilitation, which was maintained in the next 2 months of rehabilitation. The activity specific balance confidence scale (ASBCS) scores for both the groups showed improvement after every month of rehabilitation, reaching near normalcy after 3 months of rehabilitation. The gait parameters like stride, step length, and cadence were measured periodically for both the groups. The stride length of both the groups improved after 3 months of rehabilitation but experimental group showed more improvement than control group. The step length of both the groups were improved after 3 months of rehabilitation but experimental group showed more improvement than control group. The cadence of both the groups improved after 3 months of rehabilitation showing equal improvement. The TUG scores for both the groups improved after 3 months of rehabilitation but the scores of experimental groups, improved more than control group. Hence at the end of study we found that both traditional hip exercises and kinetic control exercises were effective in restoring balance and functional independence in both groups but gait parameters like stride, step length, cadence and TUG scores were significantly improved for experimental group.

6. Scope for Further Research and Limitations of the Study

Limitations:

1) Limited sample size.
2) Short duration of study.
3) The study population included subjects who have undergone total hip arthroplasty(THA) due to OA only.
4) The patients who underwent THR in NIMS were operated via posterior approach and were under strict non weight bearing period for about 4-6 weeks.

5) The procedure was uncemented in nature for all the subjects included in study.
6) The data was taken when the patient came for partial weight bearing after completing 4-6 weeks of mandatory non weight bearing period. Data was taken at department of physiotherapy, NIMS.
7) Traditional hip ROM and balance exercises are easy to understand and remember but kinetic control exercises are quite difficult in understanding and execution.

Future Scope

1) This study with large sample size and long term follow up is required to get betterresults.
2) Same study can be done using different parameters.
3) Same study can be done in subjects who have undergone THR via various approacheslike superior gluteal, direct anterior, Watson jones approach etc.
4) Same study can be done in subjects who have undergone THR via cemented procedure since they can go for immediate partial weight bearing.
5) Since in this study subjects undergoing THR due to OA were only included, studies canbe conducted in patients undergoing THR due to other pathologies also.

Conflict of Interest: None.

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