Physiotherapy in the Management of Total Knee Arthroplasty: A Review

[1]Akodu AK* , [2]Giwa SO, [1]Akinbo SRA and [1]Ahmed UA

[1]Department of physiotherapy and [2]Department of Surgery
College of Medicine, University of Lagos, Idi-Araba

Address correspondence to **AK Akodu**, E-mail:akoduashiyatkehinde@yahoo.co.uk

ABSTRACT

Background: Although total knee arthroplasty (TKA) is considered the treatment of choice for patients with intractable pain and substantial functional disabilities who have not had acceptable relief and functional improvement after conservative treatment. It was found out that patients with total knee arthroplasty need physiotherapy intervention for pre-operative and post- operative management.

Objectives: To take a critical look at the importance of TKA following destruction of the knee joint, its indications and contraindications and to ascertain the current trend involved in the physiotherapy management of TKA.

Methods: The current literature materials on physiotherapy management of TKA was reviewed.

Results: The aim of treatment is to maximize functionality and independence and to minimize complication such as deep vein thrombosis and pulmonary embolism by relieving pain using cryotherapy, improving range of motion with mobilization techniques, muscle strengthening, therapeutic exercise, transfer training, gait training and training of activities of daily living. These are administered as home programme or in organized groups led by a physiotherapist and has been shown to improve outcome related to physical activity after knee joint arthroplasty.

Conclusion: It was concluded that interventions, including physiotherapy and functional exercises after discharge, is still beneficial after TKA.

Key Words: Physiotherapy, arthroplasty, Knee

INTRODUCTION

Total knee arthroplasty (TKA) is considered the treatment of choice for patients with intractable pain and substantial functional disabilities who have not had acceptable relief and functional improvement after conservative treatment[1]. Nowadays TKA represents a very successful surgical intervention with report documenting 15 years survivorship of over 90% [2] . Worldwide 500,000 to 800,000 TKAs are performed annually . There is general conformity that exercising after TKA promotes working ability and independence in activity of daily living[3,5].

The prosthesis should be durable requiring patient to undergo only one definitive procedure in their lifetime, this might simply be unrealistic in younger patients. Approximately 130,000 knee replacement are performed every year in the United States of America (USA). Significant advances have occurred in the type and quality of the metals, polyethylene and more recently ceramics used in the prostheses manufacturing process, leading to improved longevity. As with most techniques in modern medicine, more and more patients are receiving the benefits of TKA. Patients with painful, deformed and unstable knees secondary to degenerative or inflammatory conditions need a prostheses that provides reproducible pain relief and improvement in function[4].

Physiotherapy (PT) is recommended by the American College of Rheumatology and the European League against Rheumatism in the peri-operative care for knee OA[4]. It encompasses many interventions including exercise, manual technique, knee taping and education to execute patient self management strategies. The morbidity and complications from the procedure should be minimal. The overall mortality rate from a TKA is less than one percent but this figure increases with age, sex, and the number of preexisting medical conditions [5].

RELEVANT ANATOMY

The knee joint is the largest joint of the body and is of the compound variety. It includes phylogenetically, two condylar joints between the corresponding condyles of the femur and tibia and a plane joint between the patella and the patella surface on the lower end of the femur [6].

The condylar joints are partially subdivided by two menisci placed between the corresponding articular surfaces. The articular surfaces are by no means congruent. The femoral condyles are convex from side to side and from before backwards; in profile they are spiral in shape with the curvature greatly accentuated posteriorly. The tibial articular surfaces are the cartilage enclosed area of the condyles which are separated by the intercondylar area. Each articular surface is smoothly hollowed out centrally and flattened peripherally where it is covered by the corresponding meniscus [6].

The articular surfaces on the lateral condyle is more elongated than that on the medial condyle and is concave anterioposteriorly and transversely. That on the medial condyle is shortened and wider, concave transversely and convex in the anteoposterior plane posteriorly, it is extended over the back of the condyle in relation to the popliteus tendon. Each tibial articular surface, on the other hand, though smoothly hollowed out centrally, is flattened around its periphery where it is covered with the corresponding meniscus [6].

The articular surface of the patella is modified in a general

way to the patellar surface of the femur. The vertical ridge which divides it into a larger, lateral part and a smaller, medial part fits into the corresponding groove on the femur, but the lateral and medial parts are only improperly congruent with the corresponding parts of the femur[6].

The smaller bone of the leg, the fibula has a small joint that connects it to the side of the tibia. Articular cartilage cover the end of the femur, the top of the tibia and the posterior part of the patella. Two important ligaments are found at the sides of the knee joint, medial collateral ligament and lateral collateral ligament. The knee joint has two other important ligaments which stretch between the femur and the tibia, the anterior cruciate ligament in front and posterior cruciate ligament in the back. The tendon around the knee is the patella tendon which connects the patella to the tibia. It covers the patella and extends proximally to the thigh where, it is called quadriceps tendon[7].

The motor that drives the knee joint and allows us to work is the extensor mechanism and consists of patella, patella tendon, the quadriceps tendon and the quadriceps muscles. The muscles at the back of the knee and thigh are the hamstring muscles (bicep femoris, semitendinosus, semi membranosus). The most important nerve around the knee is the popliteal nerve, it splits just above the knee to form the tibial and peroneal nerves. The major blood vessel is the popliteal artery and vein which are the main blood supply to the leg and foot[7].

BIOMECHANICS OF THE KNEE JOINT

The human knee is the largest and the most complex joint in the body. It is a two joint structure composed of the tibiofemoral joint and the patellofemoral joint. The knee transmits loads, participates in motion, aids in management of momentum and provides a force couple for activities involving the leg[8].

The fact that the knee sustains high forces and is positioned between the body's two longest lever arms makes it particularly vulnerable to injury. The knee is particularly well suitable for demonstrating biomechanical analyses of joints because these analyses can be simplified in the knee. Although knee motion occurs concurrently in three planes, the motion in one plane is so great that it accounts for nearly all of the motion. Even though many muscles produce forces on the knee, at any particular moment one muscle group predominates, generating a force so great that it accounts for most of the muscle force acting on the knee. Basic biomechanical analyses can be limited to motion in one plane and to one place and to the force produced by a single muscle group and can still give an understanding of knee motion and an estimation of the magnitude of the principal forces and moments on the knee[8].

In the tibiofemoral joint, motion takes place in all three planes, but the range of motion is maximum in the sagittal plane. Motion in this plane, from full extension to full flexion of the knee is from zero to about 140 degrees[8].

Motion in the transverse plane, internal and external rotation, is influenced by the position of the joint in the sagittal plane. With the knee in full extension, rotation is almost completely restricted by the interlocking of the femoral and tibial condyles, which occurs mainly because the medial femoral condyle is longer than the lateral condyle. The range of rotation increases as the knee is flexed reaching a maximum at 90 degrees of flexion with the knee in this position external rotation ranges from zero to just about 45 degrees and internal rotation ranges from zero to approximately 30 degrees. Beyond 90 degrees of flexion the range of internal and external rotation decreases, mainly because the soft tissues limit rotation[8].

Motion in the frontal plane, abduction and adduction, is uniformly affected by the amount of joint flexion. Full extension of the knee precludes almost all motion in the frontal plane. Passive abduction and adduction increase with knee flexion up to 30 degrees, but each reaches a maximum of only a few degrees. With the knee flexed beyond 30 degrees, motion in the frontal plane again decreases because of the limiting function of the soft tissues[8].

A two-dimensional anatomically based mathematical model of the human knee joint was developed to understand its biomechanics in deep flexion. The model was used to determine the internal knee loads as it simulates isometric quadriceps and hamstring co-contractions at different flexion angles during deep squat. It was found that in order to achieve deep flexion, large muscle forces are required, resulting in large tibio-femoral contact forces. In deep flexion, the femoral contact point was located on the most proximal point of the posterior condyle, location which was not affected by the level of quadricep activation[9].

On the other hand, the location of the tibial contact point was highly affected by the level of quadricep activation. Both anterior and posterior fiber bundles of the posterior cruciate ligament were found to carry high loads when the knee is maximally flexed. These results point to the important role of the posterior cruciate ligament in this position, and suggest the need for retaining this ligament during total knee arthroplasty (TKA) procedures that allows for maximum flexion angles. Furthermore, the present data provide an explanation why most TKA's do not permit deep flexion; where contact occurs on the most proximal points of the posterior condyles in normal knees, this portion of the condyles is not presently resurfaced when performing a TKA[9].

In the patellofemoral joint, the quadriceps muscle force increases with knee flexion. During relaxed upright standing, minimal quadriceps muscle forces are required to counterbalance the small flexion moments on the patellofemoral joint, because the center of gravity of the body above the knee is almost directly above the center of rotation of the patellofemoral joint. As knee flexion increases however the center of gravity shifts farther away from the center of rotation, thereby greatly increasing the flexion moments to be counterbalanced by the quadriceps muscle force. As the quadriceps muscle force rises, so does the patellofemoral joint reaction force[8].

Knee flexion also influences the patellofemoral joint reaction force by affecting the angle between the patellar tendon force and the quadriceps tendon force. The angle of these two force components becomes more acute with knee flexion, increasing the magnitude of the patellofemoral joint reaction force which is their resultant.[8]

Based on a model validated against patient data, it has been shown that - mainly as a result of the action of the muscles - both the tibiofemoral as well as the patellofemoral joints experience substantial mechanical loads even during normal activities of daily living. The calculations further indicate that malalignment at the knee in the frontal plane of more than approximately 4 degrees results in considerably increased forces across the tibiofemoral joint. The actual change in force to a given degree of malalignment may, however, vary significantly between subjects[10].

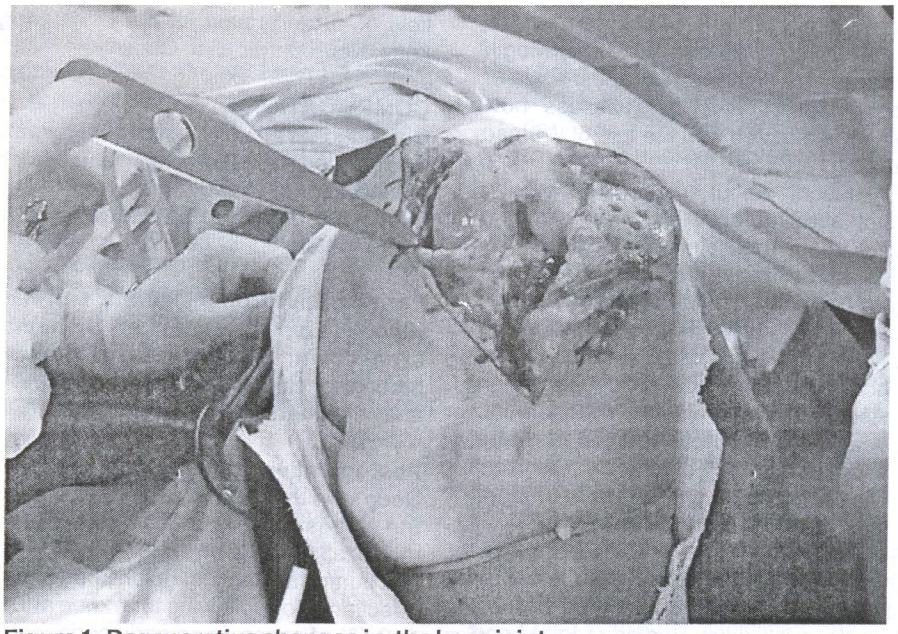

Figure 1: Degenerative changes in the knee joint [11]

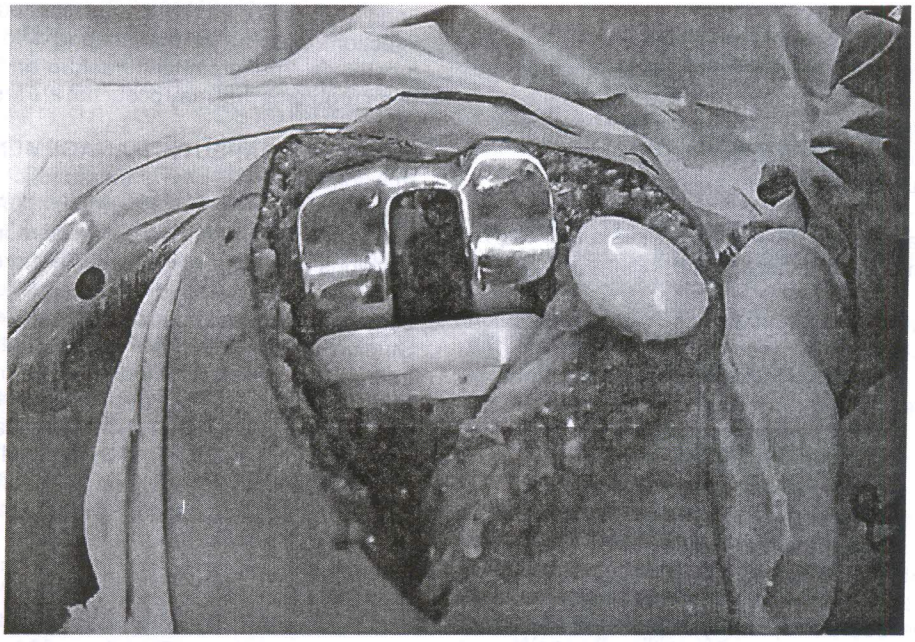

Figure2: Total Knee Replacement [11]

PATHOKINESIOLOGY

Studies have shown that there are ongoing inflammation and synovitis that result in permanent joint damage [12, 13]. At times, this may be more striking, with flares of symptoms or joint effusions. Histologically, articular cartilage comprises chondrocytes and their extracellular matrices. Three distinct zone are recognizable, superficial, middle, and deep. Mechanical or inflammatory injury that disrupts these ones can lead to irreparable damage and to further inflammation and cartilage degradation as the body attempts to heal itself [14]. Several cytokines, such as interleukin 1-â transforming growth factor, proteases and nitric oxide synthetase all appear to be essential for cartilage degradation [15].

PRESENTATION

Clinical history of a patient with degenerative changes to the knee is dominated by pain. This predominantly occurs on weight bearing and in full range of motion. It may be constant or unrelieved by rest. The pain may be localized to one compartment or may be diffuse. Other symptoms may include stiffness, swelling, locking and giving way.

Physiotherapist try to quantify the level of pain on a simple scale (e.g mild, moderate, severe or the Mcgill questionnaire assessment for pain or numerical scale of 1-10 Visual Analogue Scale (VAS) and assess how activities of daily living are affected with the use of Womac score questionnaire.
Information from patient about maximum walking distance, recreational sporting activities, stair climbing which often give clue about patellofemoral disease, the need for walking aid, the ability to dress and perform self care and the ability to perform activities that require knee flexion. Some patients may have considerable interference with social interactions, sexual function and sleep and experience exhaustion and even depression from the disease[16]. Ascertain the condition of the ligament. Seek and systematically exclude other sources of knee and leg pain e.g. root pain from spinal disease, meniscal pathology and bursitis e. t. c.

OUTCOME MEASURES

Various structured outcome evaluation can be used to try to quantify disability from dysfunction of the knee and are useful as research tools in follow up studies of total knee replacement, these include:
General health status measure e.g. (medical outcome short form 36).
Specific knee scoring system[17].

LABORATORY STUDIES

Preoperative laboratory investigations should include the following:

- Full blood count (FBC)
- ESR(erythocyte sedimentation rate)

Urinalysis and culture
Urea and electrolyte
Electrocardiogram (ECG) in patients 40 years and above (is performed in elderly patients with history of cardiac problem.
More sophisticated imaging modalities in the investigation of knee arthritis are of occasiona benefit for the assessment of significant bone loss or bone infection, these include the following:
CT Scan
MRI Scan

INDICATIONS FOR TKA

Osteoarthritic destruction of the knee is the most common reason for total knee arthroplasty. This is a disease of synovial joints characterized by degenerative and reparative processes[18]. The primary indication for TKA is to relieve pain caused by severe osteoarthritis , correction of significant deformity, significant loss of joint space. These include older patients with more modest activity, younger patients who have limited function because of systemic arthritis with multiple joint involvement, severe patellofemoral arthritis, and also those with post traumatic arthritis. Deformities can sometimes become the principal indication for knee arthroplasty in patients with moderate arthritis when flexion contracture or valgus and varus laxity is significant[19].

CONTRAINDICATIONS TO TKA

Knee sepsis, a remote source of ongoing infection, extensor mechanism dysfunction, severe vascular disease (heamophilia), recurvatum deformity secondary to muscular weakness, Psoriasis (skin conditions within the field of surgery, past history of osteomyelitis around the knee, Neuropathic joint, Obesity.

COMPLICATIONS

Classified as those specific to the operation
General complications of anaesthesia (perioperative complications)
Other medical complications e.g. neurovascular complication

Perioperative Complications

Blood loss, infection, early haemorrhage, wound breakdown, intraoperative fractures, anaesthetic problems, cardiovascular, respiratory, renal, electrolytes and other medical problems[20].

Postoperative Complications

Deep vein thrombosis is a major danger if it embolizes to the lungs. Precautions are necessary with early mobilization, use of thromboembolic disease stockings, foot pumps and anticoagulant therapy.
Infection is low following total knee arthroplasty, it occurs in 1- 2.5% of cases, in an early perioperative stage, it should be diagnosed and treated on an urgent basis.
Neurovascular complications are rare in TKA. The lateral popliteal nerve may be injured in severe valgus deformity. Tourniquet paralysis may also occur as a rare problem[21,22].
Long term problems that are associated with TKA are late infection, wearing of the bearing and loosening of the prosthesis, periprosthetic fracture and arthrofibrosis are other problems that may occur but are less common[23].

PHYSIOTHERAPEUTIC MANAGEMENT OF TKA.

Physiotherapy(PT) is a therapeutic approach in the management of osteoarthritis (OA) and a useful intervention in the perioperative care in knee OA. If OA develops and surgery is inevitable there may be a role for PT in the preoperative instructions of patients. After surgery patients are seen by PT in the rehabilitation phase.
Studies of the effect of PT intervention are difficult to interpret because most studies have not evaluated integral physiotherapy programmes but individual components, which do not really reflect typical clinical practice. People with symptomatic OA of the knee usually complain of pain, loss of function, stiffness resulting in difficulty of movement especially after a period of rest, reduced physical fitness and limitation in activity of daily living[24].
International guideline advocates non - pharmacological treatment as the first line of management for people with Oa[25]. Exercise therapy may be the physiotherapy intervention of choice, Exercises can be divided into:

a. Joint specific strengthening
b. Range of motion exercises
c. General aerobic
d. Conditioning
f. Advice on coping strategies.

A Cochrane review on the effects of therapeutic exercises has demonstrated a beneficial effect of exercise on pain and physical function for people with symptomatic knee OA[26]. Both high intensity and low intensity aerobic exercises improve functional status, pain, gait and aerobic capacity in people with OA of the knee. When conservative management fails to provide relief in OA, knee arthroplasty becomes necessary.

PREOPERATIVE EXERCISE AND EDUCATION

It is speculated that people who receive preoperative education and exercise and have already been educated about surgery and recovery will be less anxious, can tolerate the pain better and have a shorter hospital stay [27]. Unfortunately there is little evidence to support the use of preoperative education over and above standard care to improve post operative outcome in patients undergoing knee replacement surgery especially in terms of pain, functionality and length of hospital stay[27,28]. On the other hand, there is evidence that preoperative education has a modest beneficial effect on preoperative anxiety.

However, when preoperative education is tailored to anxiety or targeted at those patients in need of support e.g. those who are particularly disabled the effect is more significant[27].

PHYSIOTHERAPY DURING HOSPITAL STAY

Recent trends in health care encourages early patient discharge from hospital and substitution of inpatient care with home-based alternatives whenever they are feasible. Physiotherapy is a component of every in- hospital protocol.

Most protocols are similar and incorporate giving information on the surgery and postoperative recovery. Treatment aims to improve range of motion, muscle strength (particularly of the quadriceps) and training in activities of daily living like transferring from bed to chair, sitting to standing, walking and climbing stairs [29].

REHABILITATION DURING POSTOPERATIVE RECOVERY

After the immediate post operative in-patient period, exercise would produce long term benefits in terms of physical function in patients after TKA. Improvement in strength, balance, and other neuromuscular aspects facilitate functional activities and might prevent functional adverse outcomes such as falls.

Although exercise administered as home programme or in organized groups led by a physiotherapist, has been shown to improve outcome related to physical activity after joint arthroplasty, no difference in pain, activity of daily living, quality of life or gait parameters have been demonstrated when comparing organized group exercises with home exercise programmes [30,31] Therefore exercise at home should be advocated.

PHYSIOTHERAPY PROTOCOL POSTOPERATIVELY

Check operation notes and postoperative physiotherapy and mobility instructions.

DAY 1:

- Assess respiratory status and treat if necessary.
- Encourage circulatory exercises
- Correct position in bed, knee extended in Robert Jones bandage to
- minimize swelling (no pillow underneath the knee), with or without heel raise.
- Evaluate bed transfer mobility.
- Isometric exercise for quadriceps, hamstrings, gluteal with and without straight leg raise.
- Stand and mobilize with frame if blood pressure is well controlled and power and sensation is adequate on non operated side.

DAY 2:

- Mobilize with frame, encouraging knee flexion in swing phase of gait training.
- Continue exercise programme (as day 1) add knee flexion sliding in sitting.
- Continous passive movement (CPM) if appropriate.
- Ice therapy.

DAY 3

- Exercise programme to increase range and strength of affected knee and maintain range strength of both lower limbs (open and closed chain).
- Ice and elevation to control swelling
- Gait: assess and progress – crutches , 1or 2 sticks as appropriate.
- Balance work
- Tranfers: assess and progress to restore independence
- Step or stair practice
- Home exercise programme
- Attend occupational therapy education group when independently mobile.
- Liase with other disciplines and family as necessary
- Refer for convalescence or community services as necessary.

DISCHARGE CRITERIA

- Independent with appropriate walking aid.
- Independent with transfers.
- Independent on steps/stairs if appropriate.
- Effective with exercise programme.
- Able to control swelling with ice
- 0-90 active range of motion or expected to achieve this independently.

EXPECTED OUTCOMES AT 6 WEEKS

- Mobilising unaided around house and for increasing distance outdoors.
- Decreasing pain and swelling though not fully resolved.
- 0° to 110° degrees range of motion.
- Reasonable quadriceps and hamstrings strength
- Beginning to climb stairs normally.
- Able to perform light household activities, such as cooking, light polishing, sweeping.
- Able to swim if desired.
- Able to use ergometer, if desired.

6-8 WEEKS ONWARDS

- Review by their surgeon
- Wean off walking aid.
- Advised to gradually return to normal activities such as driving, recreational walking, sexual activity. All activity should be within comfortable limits. Patient are invited to contact their physiotherapist if they have concerns or for advice regarding their progress.

EXPECTED OUTCOME AT 6 MONTHS

- Mobilizing on aided for unlimited distance
- No pain or swelling.
- 0° to 120° of motion.
- Good lower strength (5/5).
- Able to manage stairs and slopes easily.
- Able to kneel and do all normal house hold chores such as washing.

RETURN TO ACTIVITIES

RED ALERT: Running, jogging, contact sport, high impact aerobics, jumping sport are considered dangerous activities. That are not allowed for TKA.

ORANGE ALERT: Vigorous walking, repetitive aerobics step climbing, are considered dangerous activities that should be avoided.

GREEN: driving recreational walking and swimming, recreational cycling, golf, dancing are all activities that should be encouraged and introduced gradually[36].

A REVIEW OF COMPARISON BETWEEN PATIENTS WITH TKA WHO RECEIVED PHYSIOTHERAPY AND THOSE WHO DID NOT

Utilization of physiotherapy services following knee arthroplasty is one of the most understudied aspects in the literature[35,36]. Much of the literature examines long-term outcomes following outpatient rehabilitation. Few published studies have examined the relationship between delivery of physiotherapy services and outcomes in the acute setting for patients following TKA.

Boxall et al[34] found that patients receiving TKA achieved independent transfers significantly sooner with 7-day per week physical therapy treatment. Freburger in 2000[35] concluded that patient receiving physiotherapy treatment had an increased probability of discharge directly home. These study demonstrated a positive relationship between receiving physiotherapy services and positive patient outcome.

However recent studies have shown that the outcome of physiotherapy alone with TKA did not produce any difference in outcome when compared with home exercise program.

A study by Kramer et al., 2000[36] concluded that patients who practice a home exercise program on their own have similar physical functioning at I year after surgery to those who practice home exercise program on their own and receive clinical based physiotherapy. Rajan et al., 2004[37] also deduced that there was no clinically importance difference at 1year in the degree of flexion range of motion of the knee in patient who received outpatient physiotherapy in addition to practicing a home exercise programme compared with patients practicing a home exercise protocol only after TKA.

Worland et al., 1998 [38] also concluded that continuous passive movement (CPM) in addition to practicing a home exercise program is adequate rehabilitation alternative associated with lower costs and no difference in physical functioning outcomes compared with receiving home based physiotherapy and practicing a home exercise program.

CONCLUSION

As the length of hospital stay after joint arthroplasty has markedly decreased, and given that patients who undergo knee arthroplasty may still experience considerable functional impairment postoperatively, It was concluded that interventions, including physiotherapy and functional exercises after discharge, is still beneficial after TKA[37]. However continued effective post physiotherapy intervention following TKA should be adopted after discharge.

REFERENCES

1. Brady OH, Masri BA, Garbuz DS, Duncan CP. Joint replacement of hip and knee- when to refer and what to expect . *Cmaj* 2000; 163(10): 1285-1291.
2. Insall JN, Scott W, Scuderi GR. Current concepts in primary and revision total knee arthroplasty. *Philidelphia: Lippincot* – Raven 1996.
3. Heally WL, Lorio R, Ko J, Appleby D, Lemos DW. Impact of cost reduction programs on short term patient outcome and hospital cost of total knee arthroplasty. *J bone and joint surgery Am.* 2002; 84-A(3): 348-353.
4. Jordan KM; Arden NK; Doherty M; Bannwarth B; Bijlsman JW; Dieppie p. Eular recommendation: an evidence based approach to the management of knee osteoarthritis. Report of a task force for the standing committee for the international clinical studies including therapeutic trials. *Ann Rheum Dis.* 2003; 62 (12): 1145-1155.
5. Palmer SH; Cross MJ. Total knee arthroplasty workup. *www. emedicine.medscape.com.* retrieved 9th July 2009.
6. Standring S. Anatomy of the knee joint. *Gray anatomy* 39th edition 2009; 555 -558.
7. Matt (2002). A patient guide to knee anatomy. *www. eorthopod.com.* Retrieved 9th April, 2009.
8. Nordin M, Frankel VH. Biomechanics of the knee joint. *Basic biomechanics of the musculoskeletal system.* 2nd edition 1989; 115-120. .
9. Spanu CE ; Hefzy MS. Biomechanics of the knee joint in deep flexion: a prelude to a total knee replacement that allows for maximum flexion . *Technology and Health Care* 2003; 11(3): 161-181.
10. Heller MO; Matziolis G; König C; Taylor WR; Hinterwimmer S; Graichen H; Hege HC; Bergmann G; Perka C; Duda GN. Musculoskeletal biomechanics of the knee joint. Principles of preoperative planning for osteotomy and joint replacement *Orthopade.* 2007; 36(7):628-34.
11. Total knee replacement photo www. genufix.com/total knee replacement photo. Retrieved 23rd October 2010.
12. Brooks P. Inflammation as an important feature of osteoarthritis. Bull World Health Organ.2003; 81: 689-690.
13. Ehrlich GE. The rise of osteoarthritis. Bull World Health Organ.2003; 81: 630
14. Mainil-Varlet P, Aigner T, Brittberg M. Histological assessment of cartilage repair: A report by the Histology Endpoint Committee of the International Cartilage Repair Society (ICRS). *J Bone J Surg Am.*2003; 85A: 45-57.
15. Felson DT, McLaughlin S , Goggins J. Bone marrow edema and its relation to progression of knee osteoarthritis. *Ann Intern Med.*2003; 139: 330-336.
16. Insall JN, Dorr LD, Scott RD. Rationale of the knee society clinical rating system. *Clinical orthopeadics.* 1989; 248:13-14.
17. Soderman P; Malchau H. Validity and reliability of Swedish WOMAC osteoarthritis index: a self-

administered disease –specific questionnaire (WOMAC) versus generic instrument (SF-36 and NHP) Acta orthop scand. 2000; 71(1): 39-46.

18. Chitnavis J; Sinsheimer JS; Clipsham K. Genetic influence in end stage osteoathritis sibling risk of hip and knee replacement for idiopathic osteoarthritis. *Journal of bone joint surgery Britain* 1997; 79(4): 660-664.
19. Rand JA, Ilstrup DM. Survivorship analysis of total knee arthroplasty. Cumulative rates of survival of 9200 total knee arthroplasties. *J Bone Joint Surg* [Am] 1991; 73(3): 397-40.
20. Thorey F; Stukernburg-Colsman C; Windhagen H ; Wirth CJ. The effect of tourniquet release timing on perioperative blood loss on simultaneous bilateral cemented total knee arthroplasty. A propective randomized study. *Technol Health care* 2008; 16(2): 85-92.
21. Abularrage CJ; Weiswasser JM; Dezee KJ; Slidell MB; Henderson WG; Sidawy AN. Predictors of lower extremity arterial injury after total knee or total hip arthroplasty. *J Vasc Surg.* 2008; 47(4):803-7.
22. Bayne CO; Bayne O; Peterson M; Cain E. Acute arterial thrombosis after bilateral total knee arthroplasty; *J Arthroplasty.*2008; 23(8):1239.
23. Schmalzried TP; Callaghan JJ. Wear in total hip and knee replacements. *J Bone Joint Surg Am.* 1999; 81(1):115-36.
24. Frautrel B; Hilliquin P; Rozenberg S; Alleart FA; Coste P; Leclerc A . Impact of osteoarthritis: result of a nationwide survey of 10,000 patient consulting for OA. *Joint Bone Spine* 2005; 72(3): 235-240.
25. Jordan KM; Arden NK; Doherty M; Bannwarth B; Bijlsman JW; Dieppie p. Eular recommendation: an evidence based approach to the management of knee osteoarthritis. Report of a task force for the standing committee for the international clinical studies including therapeutic trials. Ann Rheum Dis 2003; 62 (12): 1145-1155.
26. Fransen M; MacConnell S; Bell M: Exercise for the osteoarthritis of the hip and knee. Cochrane data base Sys Rev 3 2003;: CD004286.
27. Macdonald S; Hetrick S; Green S. Preoperative education for hip or knee replacement. *Chrochane Database syst* 2004; *Rev(1): CDOO3526.*
28. Butler GS; Hurley CA; Buchanan K; Smith- Vant Horne J. Pre-hospital education: effective with total hip replacement surgery patients. Patient educ couns 1996; 29(2): 189-197.
29. Kolisek FR; Gilmore KJ; Peterson EK. Slide and flex, tighten, extend (SAFTE): a safe convenient effective and cost approach to rehabilitation after total knee arthroplasty. *Journal of athroplasty.* 2000; 15(8) 10132-10136.
30. Kramer JF; Speechley M; Bourne R; Rorabeck C; Vas M. Comparison of clinic and home- based rehabilitation programs after total knee arthroplasty. *Clinic orthop Relat Re.* 2003; 410: 225-234.
31. Rajan; Pack Y; Jackson H; Gillies C; Asirvatham R. No need for outpatient physiotherapy following total knee arthroplasty: a randomized trial of 120 patient. *Acta orthop scand* 2004; 75(1): 71-73.
32. Klein GR , Levine BR; Hozack WJ; Strauss EJ; D'Antonio JA; Macauley W; Di cesare PE (2007). Return to athletic activities after total hip arthroplasty. The journal of arthroplasty 2007; 22(2):171-175.
33. NIH consensus statement on total knee replacement, Journal of Bone and Joint Surgery. 2004; 86: 1328-35. 37.
34. Boxall A, Sayers A, Kaplan GA. A cohort study of 7 day a week physiotherapy on an acute orthopedic ward. Journal of Orthopedic Nursing. 2004; 8(2): 96-102.
35. Freburger JK. An analysis of the relationship between the utilization of physical therapy services and outcomes of care for patients after total hip arthroplasty. Physical Therapy. 2000; 80(5): 448-58.
36 .Worland RL, Arredondo J, Angles F, Lopez-Jimenez F, Jessup DE. Home continous passive motion machine versus professional physical therapy following total knee replacement. Journal Arthroplasty 1998 13(7): 784- 787.
37. Catherine JM; Karen LB; Michael D; Catherine MS. Effectiveness of physiotherapy exercise after knee arthroplasty for osteoarthritis : systematic review and meta analysis of randomize control trial. *British journal of medicine* 2007; dol :10,1136/bmj.39311.460093.BE.