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Effect of AquaStretch on Range of Motion at Knee Joint in Total Knee Arthroplasty Patients

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by

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ABSTRACT

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by

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Abstract

The success of the Total Knee Arthroplasty (TKA) depends upon its functional outcomes of increase in reduction in pain, and gait ambulation and performing functional activities of daily living. Compromised range of motion, pain and weakness can reduce their ability to perform activities of daily living. Aquatic Physical Therapy may offer an alternative intervention to traditional Physical Therapy Rehabilitation and many studies have shown improvements in range of motion, swelling, pain reduction, stiffness and quality of life after TKA. AquaStretch, a relatively new form of aquatic therapy, claims to restore the functional mobility which is lost restrictions caused due to inflammatory processes. The studies done in the past compared the effects of aquatic therapy to those of land based therapy and found the two techniques to be equally effective. Currently, there is not any literature available which looks into the benefits of combining the two therapies. The purpose of this study was to investigate the effectiveness of an integrated treatment approach (Aqua Stretch and conventional therapy) compared to land therapy alone in improving range of motion after TKA.

Range of motion (ROM) data from the study group (physiotherapy and Aqua Stretch) and control group (physiotherapy only) were collected and studied retrospectively. The

ROM was compared using a 2 (groups) × 2 (pre, post) mixed model ANOVA method of statistical analysis (α=0.05).

Following the respective rehabilitation protocols, there was a significant improvement in ROM in both the groups ($p>0.05$). However, the improvement in ROM in study group was not different than that of control group ($p>0.05$).

In summary, the integrated techniques of aquatic and land based therapy was not more effective than the land based therapy in increasing the ROM at knee joint in knee replacement patients. However, other functional outcomes of knee replacement like pain, edema, strength and overall knee function are the avenues for future exploration of this technique.

INDEX WORDS: Total Knee Arthroplasty, range of motion, Aquatic therapy

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CHAPTER 1

INTRODUCTION

Background

Total Knee Arthroplasty (TKA) is one of the most clinically successful and cost-effective interventions in orthopedics.[1-3] A study presented at the 2006 Annual Meeting of American Academy of Orthopedic Surgeons projected a 673% increase to 34.8 million surgeries performed annually by the year 2030. TKA is very successful with relatively low risks, despite variations in patients' health status and type of prosthesis. Scientific and clinical evidence supports the success of TKA for the relief of knee pain and symptoms of osteoarthritis (OA), as well as a high rate of patient satisfaction.[3]

An early rehabilitation program which mainly comprised of physiotherapeutic modalities and techniques helps in restoration of function and range of motion (ROM). Modalities are applied to reduce pain and edema; therapeutic exercises are geared to enhance joint range of motion, muscle strength and endurance. Patient education and functional exercises including transfer and gait retraining helps promote physical function and quality of life.[4-5]One of the most important goals related to functional outcomes after the surgery is range of motion (ROM) at the joint.[6-9] Adequate knee function is necessary for proper gait ambulation and performance of activities of daily living.[10-11]

The physical properties of water may provide increased relaxation, ease of movement, resistance, and support with the added benefit of lower impact forces during therapeutic exercises.[12-13] Aquatic therapy has been recommended to those individuals suffering from pain, arthritis, orthopedic dysfunctions, fibromyalgia, or anything that makes land based exercise too strenuous.[14-17] Recent studies suggest that aquatic therapy

does assist in improving range of motion, functional ability and decrease pain in patients with Osteoarthritis (OA).[12-17] These studies were primarily case studies in nature or were not compared to another form of treatment. Also, there is currently not much literature available which looks into the combined benefits of the two integrated (aquatic and land) rehabilitation protocol as compared to the effectiveness of land based physical therapy.[8]

AquaStretch (AS), a relatively new form of aquatic therapy, claims to restore functional activity by clearing the surgical site of fascial adhesions limiting mobility. Thus, AquaStretch may provide an alternative treatment following a TKA since a newly constructed knee is free from any bony restriction and the reduced range is only because of soft tissue adhesions.

Therefore, the purpose of this study is to investigate the effectiveness of an integrated treatment approach (Aqua Stretch and conventional therapy) versus land therapy alone in improving range of motion after a TKA.

Purpose of the Study

The purpose of this study is to evaluate an integrated effect of conventional land based physiotherapy techniques and water based AquaStretch techniques on range of motion at knee joint in knee replacement patients as compared to conventional physiotherapy alone.

Research Questions

Research Hypothesis: There is significant improvement in range of motion at knee joint with AquaStretch exercises combined with conventional physiotherapy exercises as compared to conventional physiotherapy alone in knee replacement patients.

Null Hypothesis: There is no significant improvement in range of motion at knee joint with AquaStretch exercises combined with conventional physiotherapy exercises as compared to conventional physiotherapy alone in knee replacement patients.

Significance of the Study

This study aims at evaluating the integrated effect of Aqua Stretch (an aquatic therapy) and land based therapy on range of motion at knee joint following TKA and thus enhancing the functional ability of the patient.

Assumptions

We assume that all the rehabilitation centers follow the same standard protocol for TKA rehabilitation. We assume that all the goniometric measurements are done using standard techniques of measurement as described by Norkin and White.[56]

CHAPTER 2

REVIEW OF RELATED LITERATURE

Arthroplasty is the “plastic" or surgical restoration of a joint. Hemiarthroplasty is the surgical resurfacing of one of the two articulating surfaces of a joint; total Arthroplasty is the replacement of both sides. Unicompartmental Arthroplasty refers to the reconstruction of either the medial or lateral compartment of the knee joint and may be limited to the resurfacing of one (Unicompartmental hemi-arthroplasty) or both (Unicompartmental total Arthroplasty) of the opposing surfaces. Its primary purposes are to relieve pain and restore joint stability and motion. The cumulative degree of improvement in these factors determines the ultimate success of the procedure.[19]

The history of joint reconstruction goes back to 1827 when Barton reported an attempt to restore hip mobility by producing a surgical pseudo-arthrosis of the upper femur.[20] Since then many articles have reported the use of various animal, human, and synthetic membranes as joint resurfacing materials.[21-23]

There have been a lot of modifications done in the knee prosthesis’ material and design because of technical and bio compatible issues.[24] The metallic joint resurfacing was established by Campbell and Boyd.[18] They reported the brief use of a curved metal plate to resurface the femoral side of the knee joint. More advance methods were developed in early 1950’s, when natural knee contours were duplicated using a durable resurfacing material and preserving the stabilizing ligaments at the same time. Haboush gave the concept of cemented hip Arthroplasty by using acrylic resins as a cementing material and intensive research by Charnley made this procedure feasible.[25-26]

The position of the tibial and femoral prosthesis is very important for the correct alignment of the joint.[27-28] The mechanical axis of femur and tibia should be in proper alignment for the best results of the surgery. There has a tremendous development in the surgical procedure of replacement surgeries.[29] The development of computer assisted navigation system has replaced the manual method of locating the landmarks for insertion of prosthesis. This system assists the surgeon in making accurate bony cuts, align and orient the implants appropriately and also assess the soft tissue balancing.[30] The data pertaining to the knee anatomy send to the computer using an infrared intra-operative device during the surgery. The information about the bony alignment, position and contours of distal femur and proximal tibia is obtained and analyzed to calculate the mechanical axis of the lower extremity.[31] The surgeon cuts the bone according to information based on the mechanical axis. This technique allows adjustments to be made to approximate the best possible alignment of the prosthesis in relation to the mechanical axis of the limb.[32]

Anatomy of the knee joint

The knee is basically a hinge-type joint formed by articulation of the concave, superior surface of the tibia articulates with the convex, inferior surfaces of the femoral condyles. The normal knee joint combines a full range of flexion and extension and a few degrees of laxity in rotation-with great strength and stability.[76] The placement and attachment of the ligaments (cruciate and collateral) maintains joint stability under varying conditions of functions of flexion, extension and rotation.[77] The articulating surfaces of the bones are covered with hyaline cartilage that reduces the friction between the 2 surfaces. These surfaces are constantly lubricated, nourished and

self-repaired by the viscous synovial fluid. The articular cartilage of the femoral condyles extends anteriorly and superiorly to cover the anterior inter-condylar area thus creating a shallow concavity for articulation with the cartilage-surfaced patella.[76] There are two semi-lunar cartilages called menisci that act to absorb shock and also promote synovial fluid flow to the innermost joint surface.[76]

The two pairs of ligaments, the cruciate and collaterals are primarily responsible for the stability of the knee joint. Their functions are augmented from joint capsule and contracting muscles around the joint. The anterior and posterior cruciate ligaments are strong, short ligaments and cross one another antero-posteriorly to their respective attachment sites on inner surface of femur and tibia and hence preventing abnormal antero-posterior joint displacement.[77] The medial and lateral collateral ligaments are located outside the joint on each side and act as stress-resisting expansions of the joint capsule.[77] They provide side to side stability as their attachments run from femur above and to tibia and fibula below. These collateral ligaments are reinforced by joint capsule and the expansions of the muscular insertions. This provides additional static and dynamic support to the joint. The synovial membrane which lines the inner articulating surfaces provides a smooth, gliding, inner membrane. These structures are biomechanically arranged to provide functional stability in all planes of motion.[76]

Pathology of Knee joint

The knee is a weight bearing, highly mobile joint, that relies on the stability of the muscles, the supporting surrounding structures, low friction articular cartilage surfaces to function appropriately.[33] A defect in the articular cartilage reduces the efficiency of lubrication. Subsequent wear and tear begins which in turn leads to degradation of the

joint through loss of synovial fluid. Continued loss of joint space leads to an unstable knee due to ligament laxity. This creates the ligaments to become relaxed leading to an unstable knee already undergoing an aggravating degenerative syndrome.[34]

This arthritic process of "wear and tear" with no incidence of inflammatory disease is known as degenerative arthritis. If it developed as a result of a known injury, such as a fracture around the joint, it is known as traumatic arthritis; in absence of an overt injury, it is called hypertrophic or osteoarthritis.[35] Inflammatory conditions like rheumatoid arthritis or infectious arthritis, the articular cartilage is softening with subsequent roughening and abrasion of the articular surfaces.[36] Rheumatoid arthritis has acute episodes of remission and relapses.[36]

Indications for Total Knee Arthroplasty

Total knee Arthroplasty is indicated for severe cases of rheumatoid and degenerative arthritis and sometimes even in cases of severe joint distortion due to fracture. The decision for the surgery depends on balance of many factors including the patient's age, severity of pathology, general health and activity demands and occupational status etc.[37] A general assumption includes any patient without an infection but having severe pain and instability, regardless of the age. Contraindications are almost the same for all other orthopedic conditions including weak general health, presence of infection and weak cardio-respiratory etc.[38]

Postoperative Care

Physiotherapy plays a very important role in rehabilitation process.[39] Gentle, flexion-extension, isometric exercises are started the day after surgery. The average length of in-hospital stay after the TKA was 15 days in early 1980s.[40] However, with the advent of

new therapeutic techniques and modalities hospital stay in acute care has shortened to 3-4 days.[40]Chandler stressed on starting the rehab process immediately after the surgery at the patient' s bedside rather than waiting for the patient to go to the rehabilitation room.[41] There is emphasis on active and active assisted exercises as well as passive exercises.

The short term goals of PT aim at improving range of motion (ROM), muscle strength and functions of daily living. In an ideal situation a range of motion of 5° -90° is achieved by 1 week postoperatively.[42] The standard TKA rehabilitation protocol comprised of various ROM and strengthening exercises followed over the total period of rehabilitation. ROM flexion exercises performed without a continuous passive machine (CPM) are done either supine, prone or seated on the edge of the bed or table. Heel slide exercises are done in bed slowly. The contra lateral leg can assist by providing the overpressure while exercising. Extension exercises are equally important. The patients are encouraged to actively extend their knees at the end of the CPM cycle. Patients may stop the CPM to focus on this particular exercise to promote full extension at the knee. Active and active-assisted exercises are also encouraged to achieve appropriate strength and ROM.

Strengthening exercises of quadriceps isometrics along with ankle pumps are started on postoperative day 1. Improving muscle strength is important for independent quadriceps isometric contraction , short arc quad extension, independent straight leg raise (SLR) and controlled active extension while walking.[43] SLR are initially started with knee splint and then with splint off. Short range quadriceps exercises are done while in bed or on sitting on a chair.

Aquatic Therapy

The physical properties of water make it a unique rehabilitation tool. The force of buoyancy helps even excessively weekend individuals to overcome the resistance of weight bearing.[44] Water acts as an accommodating resistance and a patient can easily manipulate it. Strengthening Exercises performed in water are unrestricted in direction and limited only by the restriction of the joints being used.[44-45]

Hydrotherapy appears to provide short-term benefit for patients with knee or hip osteoarthritis.[46-47] This therapy is believed to be effective means of increasing joint flexibility and functional ability while reducing pain and difficulty with daily tasks.[48] Green et al found that there is little benefit in adding hydrotherapy to routine physiotherapy for osteoarthritis hip patients.[50] Wyatt et al found that there were no significant differences between the aquatic exercise group and the land-based exercise group pertaining to knee ROM, thigh girth, and time for a 1-mile walk.[51]

A randomized controlled trial by Fransen et al concluded that aquatic therapy can provide large and sustained improvements in physical function for many older, sedentary individuals with chronic hip or knee OA.[47] Although associated with improvements in function, pain relief, and/or quality of life, hydrotherapy has not been shown to be cost effective if provided in house.[51] Hydrotherapy provides buoyancy can unload the operated knee and other painful joints and may allow patients to exercise more effectively with less pain and swelling. Therefore, the inherent buoyancy and increased hydrostatic pressure of water make it a potentially attractive treatment after TKR. It is a useful method to increase cardio respiratory fitness too.

Importance of ROM

Range of Motion (ROM) is a description of how much movement exists at a joint. A joint's ROM is usually measured by the number of degrees from the starting position of a segment to its position at the end of its full range of motion. As the motion at the joint is angular, the ROM is measured in units of degree. A double armed goniometer is a device which is used commonly to measure the ROM at a joint. The stationary arm of the goniometer is placed parallel with a stationery body segment and a movable arm moves along the moving segment of the joint.

Restoration of functional ROM is the one the main determinant of the success of an Arthroplasty procedure.[52] These are the necessary knee flexion degrees to complete some of the daily life activities: 83° to climb the stairs, 90° to go downstairs and at least 105° to get up easily from a chair, 90° to take a seat and 106° to lace the shoes.[53-54] Also, the combined flexion of hip and knee should be greater than 190 degree for a functional recovery.[55] Thus the flexion range of motion significantly influences the stair climbing and walking ability of the patients.[56] Increase in ROM also lowers the pain level in patients with flexion contracture.[57]

Aqua Stretch

Aqua Stretch is a new form of aquatic exercising, which is like being stretched by an athletic trainer, but inside the water with 5 to 15 lb weights attached to the body. This technique is invented by George Eversaul, who is working as an aquatic facilitator at UNLV Student Recreational and Wellness Center. This therapy claims to work on the principle of breaking down the micro adhesions formed as a result of inflammation. After the onset of any injury or surgical process, inflammation begins and formation of micro-

calcifications can occur in the connective tissue.[58] This results in fascial adhesions at or around the associated joint. These adhesions may restrict joint movement creating and these joint movement restrictions in turn may lead to complications like pain, neurological dysfunctions and vascular insufficiencies. These fascial adhesions seem to be a normal part of healing process, and are usually naturally dissolved with normal exercise or movement. As the connective tissue around the joint tends to get hardened, it loses its flexibility.[59]

Fascial adhesions may form between bone & muscle, between two muscles, between skin and bone, i.e. surgical incision sites, and within fascial sheets.[60] They have been observed to develop in athletes and others involved in intensive physical conditioning or who suffered multiple injuries over years have also been observed to form fascial adhesions.[61] This happen as there is no sufficient time for healing when they are injured. This results in relatively permanent fascial adhesions that lead to relatively permanent fascial adhesions causing loss in flexibility with pain on movement.[62]

Aqua Stretch exercising claims to quickly dissolve fascial adhesions and realign the soft tissue dislocation. The fundamental principle underlying the treatment is to accentuate the body's natural intuitive movement that occurs when all the joints are subjected to stretch pressure. Under the influence of low gravity environment of water, the body may stretch in positions it cannot while under the influence of normal gravity and too for much longer periods of time. Another benefit of the technique is the stretching of connective tissue alone rather than the muscles.

CHAPTER 3

METHODS

Range of motion data of twenty-seven patients who underwent TKA and then subsequent physiotherapy during the period of 2009 to 2011were included in this study. Patient's relevant data were collected from Silver Ridge Healthcare Center (Las Vegas, Nevada), Parkway Rehabilitation (Las Vegas, Nevada) and Progress Rehabilitation Orthopedic, Inc. (Lake Havasu City, Arizona) and was studied retrospectively.
The study was reviewed and approved by UNLV Institutional Review Board.

Table 1: Demographics

Description	Control Group	Study Group
No of Patients	16	7
Women	7	3
Men	9	4
Age	68.9±5.8	69.4±4.72

The patient population was divided into 2 different groups. The control group consisted of 16 patients undergoing conventional physiotherapy. The study group comprised of 7 patients receiving Aqua Stretch techniques of mobilization along with conventional physiotherapy. Patients between the ages of 65-75 years were included in this study. These patients had a well healed scar with replacement surgery done within 3 months. Patients who had undergone bilateral TKA, any hip pathology, infection and

revision Arthroplasty were excluded. Patients with any deformity and contracture were also excluded.

Instrumentation

Physiotherapy regime was same for both the groups, following US standard protocols for knee rehabilitation during the acute care period. Following discharge from acute health care, the patients were referred to rehabilitation facilities for outpatient physiotherapy.

Patients in both groups were undergoing conventional rehabilitation techniques of strengthening, stretching, gait training, and other functional rehabilitation techniques. The study group was exposed to mobilization techniques of Aqua Stretch along with routine physiotherapy regime (See Appendix II).

The active ROM was measured by physiotherapists using standard goniometry techniques.[65] The patient's position was in supine with hip and knee in neutral rotation. The trunk and pelvis was stabilized by the patient's body weight and position. The center of the fulcrum was placed on lateral condyle of the femur with the reference of greater trochanter. The proximal fixed arm was aligned with the long axis of the femur while the distal mobile was aligned with tibia pointing at lateral malleolus. The patient was asked to bend the knee as far as possible and the reading on the goniometer was noted.

Goniometric measurements were done on the subsequent day of treatment before starting the current session.

Collection of the Data

The records of these patients were reviewed with careful attention paid to time frame between surgery date and start of physiotherapy, number of physiotherapy and Aqua Stretch sessions, as well as admission ROM and discharge ROM.

Data Analysis Methods

A mixed model ANOVA test was performed to analyze the data using SPSS 18 statistical analysis software. The initial ROM was compared to the final ROM for all the subjects using the within subjects model. The initial and final ROM was also measured for the subjects between the two different groups using the between group model.

Limitation of the study

The date of start of outpatient physiotherapy after surgery is highly variable and differs from patient to patient. Some patients start the therapy right after the acute care while some starts months after their discharge from the hospital. Also, the data available for aquatic group is very small in number. There are very few aquatic therapy centers and therapists who are currently practicing aquatic therapy and hence difficult to obtain a high number to compare with the conventional physiotherapy group.

CHAPTER 4

RESULTS

The final data were analyzed on 16 patients in the conventional therapy control group and 7 patients in the AquaStretch study group. The patients in the control group started the outpatient therapy within 22.6±6.7 days (Table 1) from the date of surgery and the average length of rehabilitation were 57.8±10.27 days (Table 1). The average no of sessions were 22.06±3.06 sessions for this group (Table 1).

Table 1: Therapy Dates and number of sessions for Control Group

Case #	Start of therapy (Days from surgery)	Days of Rehabilitation	No of Sessions
1	23	67	19
2	22	75	18
3	25	56	19
4	24	43	21
5	31	44	22
6	30	55	22
7	15	45	21
8	25	50	19
9	23	51	26
10	11	66	25
11	23	62	24
12	26	67	22
13	24	74	21
14	26	52	30
15	14	64	23
16	21	55	21

The patients in the study group started their outpatient therapy within 21.2±7.3 days (Table 2) from the date of surgery. The average numbers of sessions were 23.8±3.18 sessions (Table 2) over the period of 52.5±8.24 days of rehabilitation (Table 2).

Table 2: Therapy dates and number of sessions for study group.

Case #	Start of therapy (Days from surgery)	Days of Rehabilitation	No of Sessions	
			PT	AS
1	25	69	22	5
2	20	49	25	5
3	20	51	24	4
4	24	54	20	4
5	18	45	24	12
6	18	55	30	5
7	24	45	22	4

An independent t-test of the days of start of surgery between two groups (Appendix VIII) showed no statistical significant difference ($F=0.701$, $p>0.412$). Similar test for days of rehabilitation between the two groups (Appendix IX) also showed no difference in rehabilitation period between the groups ($F=1.648$, $p=0.213$). Another t-test was done for number of sessions in the two groups (Appendix X) which showed that there was no statistical difference in number of sessions offered in either of the groups ($F=0.003$, $p=0.960$).

Analysis of the ROM data showed that the patients in control group were admitted with a mean ROM of 101.25°±9.61° were discharged with a ROM of 116.75°±6.79°, so with an increase of 15.5° ± 3.7°(Table 3).

Table 3: ROM data for the control group

Case #	No of Sessions	Initial ROM (in degrees)	Final ROM (in degrees)	Improvement in ROM (in degrees)
1	17	115	130	15
2	18	90	105	15
3	19	98	115	17
4	17	85	115	30
5	20	109	116	7
6	19	108	117	9
7	21	115	127	12
8	19	90	107	17
9	26	98	118	20
10	18	95	122	27
11	20	108	119	11
12	19	99	118	19
13	20	102	117	15
14	30	111	122	11
15	19	95	113	18
16	21	92	107	15

The patients in the study group were admitted with a mean ROM of 97.71±21.13°and were discharged with a mean of 118.49±18.45° with an average increase of 21.48°±1.55° (Table 4).

Table 4: ROM data for the study group

Case #	No of PT Sessions	No of AS Sessions	Initial ROM (in degree)	Final ROM (in degree)	Improvement in ROM (in degree)
1	22	5	107	125	18
2	25	5	100	129	29
3	24	4	102	129	27
4	20	4	122	135	13
5	24	12	65	96	31
6	30	5	115	137	22
7	22	4	73	88	15

Table 5: Summary of ROM and number of sessions for both groups.

Therapy	No of Subject	No of Sessions	Initial ROM (in degree)	Final ROM (in degree)
PT only	16	22.06±3.06	101.25±9.61	116.75±6.7
PT and AS	7	23.8±3.18	97.71±21.13	118.49±18.45

A mixed model ANOVA statistical test of within subjects (Appendix VI) showed that the interaction effect was not significant for both the groups (Appendix VI) with different type of therapies ($F=2.856$, $p=0.106$). There was an increase in range of motion over the period of time in both groups ($F= 137.773$, $p<0.05$).

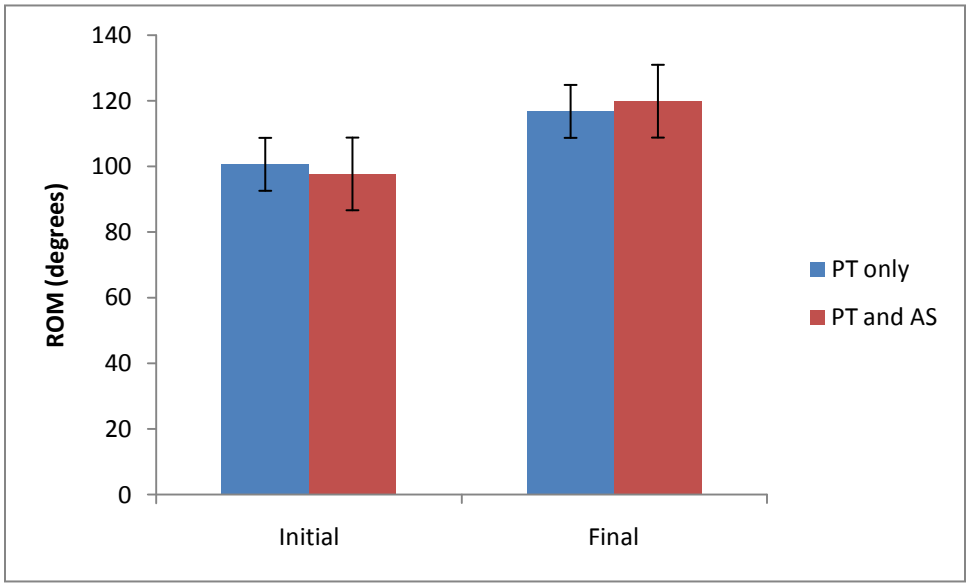

Fig 1: Graph depicting ROM over the period of time with both therapies (with error bars with standard error)

However, the test of between groups (Appendix VII) showed that improvement in the ROM in both the groups was not statistically different, $F=0.28$, $p=0.869$.

CHAPTER 5

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The arthritic process of wear and tear of knee joint leads to degradation of joint fluid, ligament laxity, reduction of joint spaces, osteophytes formation and thus cause a painful aggravating degenerative syndrome. In cases of severe disability and failure of conservative treatment, knee replacement surgery is the treatment of choice. Total knee Arthroplasty is indicated for severe cases of rheumatoid and degenerative arthritis and sometimes even in cases of severe joint distortion due to fracture. The decision for the surgery depends on balance of many factors like patient's age, severity of pathology, general health activity demands and occupational status etc.[38]

There has been a tremendous increase in the number knee replacement surgeries and at the same time, the length of hospitalization has been reduced drastically.[40]A newly constructed knee joint is free from any bony restriction but is very stiff because of adhesions formed as a part of inflammatory processes in response to surgical intervention. Physiotherapy plays an important part in rehabilitation of the knee following the surgery. Restoration of functional range of motion at knee joint after knee replacement surgery is one of the measures of success of the surgery.[8]

AquaStretch, a newer form of aquatic therapy claims to work on the principle of breaking down the fascial adhesions and restore the lost flexibility and relief of associated dysfunctions. The fascial adhesions are formed as a result of injury to soft tissues or muscles, which lead to restriction movement at the involved joint and thus reduction in flexibility. The loss of flexibility is attributed to hardening of the connective tissue around the joint.[61] Conventional physiotherapy uses a purely land based techniques

of strengthening the knee musculature and restoration of flexibility at knee joint through various mobilization techniques.[40] Aquatic therapy, on the other hand has complex thermal, mechanic, and inherent mechanical forces of buoyancy, pressure, cohesion, and viscosity that play a role in the effects produced on the body from water.[13] Studies have claimed the assistive, resistive and supportive qualities of the water which make it possible for patients to begin range of motion, strength, and endurance exercise.[14] Studies have shown increase in range of motion in cases of soft tissue injury and severe cases of muscle spasm in neurological disorders with hydrotherapy.[46]

This retrospective study investigated the effectiveness of combining an aquatic and land based program in comparison to land based therapy program alone for TKA rehabilitation. The therapeutic properties of water combined with conventional land techniques were supposed to have an additive effect on the rehabilitation process. The ROM at discharge from acute care was found to be around 95 degree which is in accordance to some studies done in the past.[67-69]

There was no difference in time frame between the date of surgery and start of outpatient therapy for both the groups ($p<0.05$). The control group started their therapy within 22.6±6.7 days and the study group within 21.2±7.3 days from the date of surgery. The physiotherapy protocol was same for both the groups which were in accordance with US standard Knee replacement rehabilitation protocol.[75] The study group was exposed to AquaStretch sessions in addition to conventional physiotherapy by an experienced aqua therapist.

The average length of rehabilitation and number of sessions were also the same for both the groups ($p<0.05$). The control group received 22.06±3.06 sessions over a period

of 57.8±10.27 days while the study group received 23.18±3.18 sessions over the 52.5±8.24 days of rehabilitation. This suggested that the two groups were quite uniform and were undergoing similar physiotherapeutic protocol with the study group receiving additional AquaStretch sessions.

Analysis of the final ROM data for both the groups showed that there was improvement in the ROM in both the groups over the period of the time ($F=137.77$, $p<0.05$). This suggested that both the therapeutic approaches were effective in improving ROM at knee. However, the increase in ROM in AquaStretch group was not statistically different from the conventional physiotherapy group ($F=0.028$, $p=.869$). This suggested that the integrated approach has no additional benefits over the conventional treatment approach.

No researchers in the past have compared the effectiveness of an integrated treatment approach (water combined with land techniques) with those of land techniques only. There are few studies done on knee replacement rehabilitation which compares the functional outcomes of aquatic therapy techniques compared to land based therapy.[18, 70-72] Harmer et al found no significant difference in knee ROM, pain levels and knee edema in patients undergoing conventional physiotherapy compared with patients in aquatic therapy group[8]. A similar study by Licciardone et al on knee and hip replacement patients also concluded that both therapies were equally effective.[69] Another study done by Tovin et al compared the effectiveness of aquatic therapy on anterior cruciate ligament reconstruction with that of conventional physiotherapy regime.[72] They increase in ROM and relief of pain was not statistically different in both the groups.

There have been some studies done to evaluate the effectiveness of aquatic therapy on ROM in osteoarthritis patients. Wang et al found a 12 week aquatic therapy program to be as effective as land therapy for osteoarthritis patients.[74] They found that the aquatic exercises have improved the knee and hip flexibility, strength and aerobic fitness but the results were not statistically different from the other group except for flexibility.

It was believed that the beneficial effects of Aquatic therapy when combined with land therapy will have an additive effect on ROM in TKA patients as studies mentioned above have advocated the efficacy of aquatic therapy. To the best of my knowledge this is the first study to investigate an integrated treatment approach for TKA due to osteoarthritis. Although the results are not supporting the research hypothesis, however this study will encourage more therapists working in aquatic physical therapy to perform future research studies utilizing an integrated treatment protocol for various other diagnoses.

Conclusions and Recommendations for Further Study

The use of an integrated approach exhibited no additional benefits in increasing ROM in TKA patients as compared to conventional therapy alone. There was no statistical difference in improvement in range of motion between the treatment regimens. Thus, it is concluded that the AquaStretch combined with conventional physical therapy is not more effective in increasing ROM at Knee joint. However, other functional outcomes of knee replacement surgery such as pain levels during rehabilitation, muscle strength; knee edema and knee functions can be explored using this technique. The levels of pain can be looked for using some standardized tools like modified Oswestry scale to see the effects of the integrated therapy on pain levels as compared to the land therapy alone. The effects

on knee functions and related activities of daily living can be looked for by using the Western Ontario and McMaster Universities Arthritis Index (WOMAC) scale. This a scale used worldwide to assess the pain, joint stiffness, physical, social & emotional function of a person with osteoarthritis in determining the overall level of disability or functionality.

Also, it is very important to establish cost effectiveness of the hydrotherapy in comparison to the land therapy regimes. Hydrotherapy pool is an expensive set-up and it would be interesting to find out the cost effectiveness of the combined approach. The role of this combination therapy can also be tested for various other diagnoses like ligament reconstruction rehabilitation, cases of neural spasticity and chronic soft tissue injuries.

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Appendix I

IRB Approval

UNLV
UNIVERSITY OF NEVADA LAS VEGAS

Biomedical IRB – Exempt Review
Deemed Exempt

DATE: **May 24**, 2011

TO: **Dr. John Young,** Kinesiology

FROM: Office of Research Integrity – Human Subjects

RE: Notification of review by /John Mercer/Dr. John Mercer, Chair
Protocol Title: Aqua-stretch and Knee Joint Range of Motion in Knee Joint Replacement Patients
Protocol # 1104-3797M

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This memorandum is notification that the project referenced above has been reviewed as indicated in Federal regulatory statutes 45CFR46 and deemed exempt under 45 CFR 46.101(b)4.

Any changes to the application may cause this project to require a different level of IRB review. Should any changes need to be made, please submit a **Modification Form**. When the above-referenced project has been completed, please submit a **Continuing Review/Progress Completion report** to notify ORI – HS of its closure.

If you have questions or require any assistance, please contact the Office of Research Integrity - Human Subjects at IRB@unlv.edu or call 895-2794.

APPENDIX II Conventional

Physiotherapy Regime APPENDIX

II

PHASE I: EARLY FUNCTION (WEEK 1)

Goals:

1. Demonstrate safe and independent transfers from bed and various surfaces.

2. Demonstrate safe and independent ambulation with appropriate assistant device.

3. Negotiate steps safely with wide based quad cane (WBQC) or crutches.

4. Demonstrate fair to good static and dynamic balance with appropriate assistant device.

5. Attain full extension (0°) and 100° flexion of the involved knee.

6. Demonstrate home exercise program (HEP) accurately.

Day of Surgery

• CPM 0-100° started in Recovery Room for minimum of 4 hours.

• Ice for 20 minutes every 1-2 hours.

• A towel roll should be placed under the ankle when the CPM is not in use.

POD #1

• Increase CPM approximately 10° (more if tolerated). Continue daily until patient achieves 100° of active knee flexion.

• Ice involved knee for 15 minutes for minimum of 3 times per day (more if necessary).

• Review and perform all bedside exercises which include ankle pumps, quadriceps sets, gluteal sets, and heel slides.

• Sit at the edge of bed with necessary assistance.

• Ambulate with standard walker 15’ with moderate assistance.

• Sit in a chair for 15 minutes.

• Actively move knee 0-70°.

POD #2

• Continue as above with emphasis on improving ROM, performing proper gait pattern with assistant device, decreasing pain and swelling, and promoting independence with functional activities.

• Perform bed exercises independently 5 times per day.

• Perform bed mobility and transfers with minimum assistance.

• Ambulate with standard walker 75-100^{o} with contact guarding.

• Ambulate to the bathroom and review toilet transfers.

• Sit in a chair for 30 minutes twice per day, in addition to all meals.

• Actively move knee 0-80°.

POD #3

• Continue as above.

• Perform bed mobility and transfers with contact guarding.

• Ambulate with standard walker 150^{o} with supervision.

• Ambulate with WBQC 150^{o} with contact guarding.

• Negotiate 4 steps with necessary assistance.

• Begin standing hip flexion and knee flexion exercises.

• Sit in a chair for most of the day, including all meals. Limit sitting to 45 minutes in a single session.

• Use bathroom with assistance for all toileting needs.

• Actively move knee 0-90°.

POD #4

• Continue as above.

• Perform bed mobility and transfers independently.

• Ambulate with WBQC 300’ with distant supervision.

• Negotiate 4-8 steps with necessary assistance.

• Perform HEP with assistance. Continue to sit in chair for all meals and most of the day.

Be sure to stand and stretch your operated leg every 45 minutes.

• Actively move knee 0-95°.

• Discharge from the hospital to home if ambulating and negotiating stairs independently.

POD #5

• Continue as above.

• Perform bed mobility and transfers independently.

• Ambulate with WBQC 400’ independently.

• Negotiate 4-8 steps with WBQC safely.

• Perform HEP independently.

• Actively move knee 0-100°.

• Discharge from the hospital to home.

Appendix III

Sample AquaStretch Therapy Regime

AquaStretch
Knee

Name:_____ **Dx:**_____ **Precautions**_____

Exercise **Date:**											
ROM/SPL Before Treatment											
Footwork: Foot, Ankle, Toe, Grip											
Lower Leg (Gastroc/Soleus Achilles, Peroneals)											
IT Pump/Palpation											
Leg Over Shoulder (Wall hang; Patella, incision)											
Leg Riding/Knee flexion											
Thigh Riding/Quad Release											
Standing Knee Flexion											
One Leg Standing											
ROM/SPL After Treatment											
Total AquaStretch Time/Initials											

Appendix IV

Sample Data Collection sheet for Conventional Physiotherapy patients

Case #	AGE	SEX	DOS	PT dates	No of Sessions	Initial Extension	Initial Flexion	Final Extension	Final Flexion

DOS Date of Surgery
PT dates Physiotherapy dates

Appendix V

Sample Data Collection sheet for AquaStretch and Physiotherapy patients

Case #	Age	DOS	PT Dates	Total PT Visits	Total A/S Visits*	ROM Start of A/S (in degrees)		ROM End of A/S (D/C)*	
1									
2									
3									
4									
5									
6									
7									

DOS	Date of Surgery
PT dates	Physiotherapy dates
A/S	AquaStretch
ROM	Range of Motion
D/C	Discharge

Appendix VI

Tests of Within-Subjects Effects

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Observed Power[a]
Time	3193.16	1	3193.16	137.773	0	0.868	1
Time * Therapy	66.199	1	66.199	2.856	0.106	0.12	0.364

Appendix VII

Tests of Between-Subjects Effects

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Observed Power[a]
Therapy	8.398	1	8.398	0.028	0.869	0.001	0.053
Error	6316.43	21	300.782				

Appendix VIII

Independent t-test for days of start of therapy

Days of start of therapy	Levene's Test for Equality of Variances		t-test for Equality of Means		
	F	Sig.	Sig. (2-tailed)	Mean Difference	Std. Error Difference
	0.701	0.412	0.528	-1.40179	2.18198

Appendix IX

Independent t-test for Days of rehabilitation for both groups

Days of Rehabilitation	Levene's Test for Equality of Variances		t-test for Equality of Means			
	F	Sig.	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
	1.648	.213	21	.243	5.30357	4.41298

Appendix X

Independent t-test for no of therapy sessions in both groups

No of Sessions	Levene's Test for Equality of Variances		t-test for Equality of Means			
	F	Sig.	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
	.003	.960	21	.215	-1.79464	1.40475

VITA

Graduate College

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Home Address: 2101 Hussium Hills St, #101 Las Vegas, Nevada 89108

Degrees: Bachelors in Physiotherapy,

Guru Nanak Dev University, Amritsar, India

Thesis Title: Effect of Aqua Stretch on range of motion at Knee Joint in Total Knee Arthroplasty Patients

Thesis Examination Committee:

Chair, Dr. Jack Young, Ph. D.

Committee Member, Dr. Richard D Tandy, Ph. D.

Committee Member, Dr. John Mercer, Ph. D.

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