COMPARATIVE STUDY OF CONVENTIONAL PHYSIOTHERAPY, ELECTROMYOGRAPHY (EMG) BIOFEEDBACK AND ISOKINETIC EXERCISE INTERVENTION IN PERSON SUFFERING OSTEOARTHRITIS OF KNEE

By

FARIDAHIDAYU BINTI AMRIZAL

Dissertation submitted in partially fulfilment

of the requirements for the degree of Bachelor of Health Sciences

(Exercise and Sport Science)

JUNE 2015

CERTIFICATE

ACKNOWLEDGEMENTS

I thank God for this opportunities that given me to do my thesis with giving me courage, focus and strength to complete this thesis.

I also would like to express my deepest thanks to my supervisor Dr. Srilekha Saha, for encouragement, guidance and support me throughout the preparation of this dissertation.

I wish to express my sincere thanks to Prof. Dr Amran Bin Shokri, who had helped me in the selection of Knee Osteoarthritis patient.

My greatest gratitude to the Chairman of Exercise and Sport Science course, Associated Prof. Dr. Mohamed Saat Ismail for his continuous encouragement.

I also would like to express my gratitude to Dr. Soumendra Saha for his guidance and support throughout the research.

I also would like to thanks Ms. Foujia Huda, Ms. Faria Sultana, Mr. Maruf Ahmed, Mr Naresh, Mrs Fara Izati and Mrs.Choo Morlie Liza for helping me throughout the research.

Special thanks to my helpful friend Miss Nabihah Ali as my co-partner who had helped me a lot during my research study.

Also special thanks to all Exercise and Sport Science Officer and staffs of USM especially to Mr. Hafezi Mat Zain, Mrs. Mazra Othman, and Mrs. Mardhiah Mohamed for their co-operation to allow me used the laboratory and instrument for this study. Not to forget to all my beloved classmate and lecturers.

My greatest gratitude to all participants who volunteered themselves to participate in my study.

My lovely thank to my beloved family for all the support during the research period. Without them, I don't think I can be this strong and tough to complete this thesis.

CONTENT

CHAPTER I: INTRODUCTION

1.1. STUDY BACKGROUND

1.1.1. Osteoarthritis (OA) 1

1.1.2 Exercise Intervention for Osteoarthritis 3

1.1.2.1 Conventional Physiotherapy 4

1.1.2.2 Electromyography (EMG) Biofeedback 5

1.1.2.3 Isokinetic Training 5

1.2 SIGNIFICANCE OF THE STUDY 6

1.3 OBJECTIVES OF THE STUDY 7

1.3.1 General Objective 7

1.3.2 Specific Objectives 7

1.4 RESEARCH HYPOTHESIS 8

CHAPTER II: REVIEW OF PREVIOUS LITERATURE REVIEW

2.1 EFFECT OF CONVENTIONAL PHYSIOTHERAPY ON OSTEOARTHRITIS 9

2.2 ELECTROMYOGRAPHY BIOFEEDBACK (EMGBF) AND QUADRICEPS MUSCLE FUNCTION 11

2.3 ELECTROMYOGRAPHY BIOFEEDBACK (EMGBF) ON KNEE OUTCOMES IN OSTEOARTHRITIS 13

2.4 ISOKINETIC TRAINING AND MUSCLE FUNCTION 14

2.5 SUMMARY OF LITERATURE REVIEWS 16

CHAPTER III - METHODOLOGY

PART A: GENERAL METHODOLOGY

A.1 INTRODUCTION 17

A.2 WESTERN ONTARIO AND MCMASTER UNIVERSITIES ARTHRITIS INDEX (WOMAC) 18

A.2.1 Introduction 18

A.2.2 Analysis of Data 19

A.2.3 Interpretation of Data 19

A.3 ISOKINETIC BIODEX 4 MULTI-JOINT SYSTEM

A.3.1 Introduction 19

A.3.2 Analysis of Data 19

A.3.3 Interpretation of Data 20

A.4 FORCE PLATFORM AND 3D QUALISYS TRACK MANAGER

A.4.1 Force platform

A.4.1.1 Introduction 21

A.4.1.2 Analysis of Data 22

A.4.1.3 Interpretation of Data 22

A.4.2 3Dimensional Qualisys Track Manager (QTM)

A.4.2.1 Introduction 23

A.4.2.2 Analysis of Data 24

A.4.2.3 Interpretation of Data 24

A.5 ELECTROMYOGRAPHY (MEGA ME6000) BIOMONITOR

A.5.1 Introduction 25

PART B: PRESENT STUDY

B.1 INTRODUCTION 26

B.2 METHODS

B.2.1 Participant 27

B.2.2 Inclusion Criteria 28

B.2.3 Exclusion Criteria 29

B.3 MATERIAL USED 29

B.4 INTERVENTION TECHNIQUE EMPLOYED

B.4.1 Conventional Physiotherapy Exercise Intervention

B.4.1.1 Strengthening Exercise 30

B.4.1.2 Stretching Exercise 35

B.4.1.3 Range Motion Exercise 37

B.4.2 Electromyography (EMG) Biofeedback Exercise Intervention 39

B.4.2.1 Quadriceps Isometric Contraction 40

B.4.2.2 Hip Adduction 41

B.4.2.3 4 Ways Straight Leg Raise (Slr) 42

B.4.2.4 45° Knee Extention 44

B.4.3 Isokinetic Exercise Intervention 45

B.5 PRESENT STUDY PROCEDURE 46

B.6 STATISTICAL ANALYSIS 48

B.7 FLOW CHART 48

B.8 GANTT CHART 50

CHAPTER IV – RESULT 51

CHAPTER V – DISCUSSION 64

CHAPTER VI - CONCLUSION 70

REFERENCES 73

APPENDIXES

APPENDIX A – LETTER FROM USM ETHICS COMMITTEE 83

APPENDIX B– CONSENT FORM 88

APPENDIX C – WOMAC QUESTIONNAIRE 100

LIST OF TABLES

Table 1 - Protocol of strengthening exercise

Table 2 - Protocol of stretching exercise

Table 3 - Protocol of range of motion exercise

Table 4 - Protocol of Quadriceps Isometric Contraction

Table 5 - Protocol of Hip Adduction

Table 6 - Protocol of 4 Ways Straight Leg Raise (SLR)

Table 7 - Protocol of 45° knee extension

Table 8 - Protocol of Isokinetic Exercise Intervention

Table 9 - Kellgren and Lawrence Classification of Osteoarthritis of Knee

Table 10 - Descriptive outcome for pre-intervention analyses obtained from the participants of the Conventional exercise training group

Table 11 - Descriptive outcomes for pre-intervention analyses obtained from the participants of the EMG biofeedback training group

Table 12 - Descriptive outcomes for pre-intervention analyses obtained from the participants of the Isokinetic exercise training group

Table 13 - Descriptive outcome for post-intervention analyses obtained from the participants of the Conventional exercise training group

Table 14 - Descriptive outcomes for post-intervention analyses obtained from the participants of the EMG biofeedback training group

Table 15 - Descriptive outcomes for post-intervention analyses obtained from the participants of the Isokinetic exercise training group

Table 16 - Means and Mean Differences in the Level of Peak Torque for Three Different Groups across the Experimental Sessions

Table 17 - Means and Mean Differences in the Level of Peak Torque for Three Different Groups across the Experimental Sessions

Table 18 - Means and Mean Differences in the Level of Peak Torque for Three Different Groups across the Experimental Sessions

Table 19 - Means and Mean Differences in the Level of Peak Torque for Three Different Groups across the Experimental Sessions

Table 20 - Means and Mean Differences in the Level of Peak Torque for Three Different Groups across the Experimental Sessions

Table 21 - Means and Mean Differences in the Level of Peak Torque for Three Different Groups across the Experimental Sessions

Table 22 - Means and Mean Differences in the Level of Peak Torque for Three Different Groups across the Experimental Sessions

Table 23 - Means and Mean Differences in the Level of Peak Torque for Three Different Groups across the Experimental Sessions

Table 24 - Mauchly's Test of Sphericitya (Measure: MEASURE_1 Obtained on EMG parameters)

Table 25 - Tests of Within-Subjects Effects (Measure: MEASURE_1 Obtained on EMG parameters)

Table 26 - Mauchly's Test of Sphericityb (Measure: MEASURE_2 Obtained on Isokinetic Peak Torque parameters)

Table 27 - Tests of Within-Subjects Effects (Measure: MEASURE_1 Obtained on Isokinetic Peak Torque parameters)

Table 28 - Multiple Linear regression report based on WOMAC questionnaire (Health index)

Table 29 - Multiple Linear regression report based on WOMAC questionnaire

LIST OF FIGURES

List of Figure in Chapter III

Figure 1 - Isokenetic Biodex 4 Multi Joint System

Figure 2 - Force platform and 3Dimensional Qualisys Track Manager (QTM)

Figure 3- Electromyography (Mega Me6000) Biomonitor

Figure 4 - Sample size calculation.

Figure 5 - Electrode attachments (Left- Vastus medialis, Right- Vastus Lateralis)

Figure 6 - Flow Chart of Study Design

Figure 7 - Gantt Chart

List of Figure in Chapter V

Figure 1 - Represents the EMG maximal voluntary contraction states observed during pre-intervention analysis.for conventional physiotherapy group intervention.

Figure 2 - Represents the EMG maximal voluntary contraction states observed during post-intervention analysis.for conventional physiotherapy group

Figure 3 - Represents the EMG maximal voluntary contraction states observed during pre-intervention analysis.for EMG biofeedback group intervention.

Figure 4 - Represents the EMG maximal voluntary contraction states observed during post-intervention analysis.for EMG biofeedback group intervention.

Figure 5 - Represents the EMG maximal voluntary contraction states observed during pre-intervention analysis.for isokinetic group intervention.

Figure 6 - Represents the EMG maximal voluntary contraction states observed during post-intervention analysis.for isokinetic group intervention.

LIST OF ABBREVIATION

°/s	Degrees per Second
3D	3Dimensional
ACL	Anterior Cruciate Ligament
ACR	American College of Rheumatology
ASIS	Anterior Superior Iliac Spine
bm	Body Mass
COP	Centre of Pressure
COPCORD	Community - Oriented Program for the Control of Rheumatic Diseases
EMG	Electromyography
EMGBF	Electromyography biofeedback
FM	Fibromyalgia syndrome
GAG	Glycosaminoglycan
Gr.	Group
HUSM	Hospital Universiti Sains Malaysia
ISIS	Inferior Superior Iliac Spine
J	Joules.
kg	Kilogram
MVC	Maximal Voluntary Contraction
N	Newton
Nm	Newton meters
OA	Osteoarthritis

PT	Peak torque
QTM	Qualisys Track Manager
RA	Rheumatoid arthritis
ROM	Range of Motion
RT	Relative torque
SLR	Straight Legs Raise
SPSS	Statistical Package foe Social Sciences
VAS	Visual Analog Scale
VL	Vastus Lateralis
VM	Vastus Medialis
W	Watts
WHO	World Health Organization
WOMAC	Western Ontario And Mcmaster Universities Arthritis Index
ZCR	Frequencies of EMG activity

ABSTRACT

The present study was undertaken with an objective to To compare the effectiveness of conventional physiotherapy, electromyography (EMG) biofeedback and isokinetic exercise intervention on person suffering osteoarthritis (OA) of knee. Twenty eight cases on osteoarthritis of knee from Hospital Universiti Sains Malaysia (HUSM) in the age above 50 years old are involved. All cases involved then assessed with Western Ontario And Mcmaster Universities Arthritis Index (WOMAC) questionnaire, peak torque using Biodex 4 Isokinetic machine, Standing force and knee joint force using Force Platform And 3Dimensional (3D) Qualisys Track Manager software and muscle activation using electromyoghaphy (EMG). These assessments were done for the screening test and pre-intervention base line information. Thereafter they were randomly and equally categorized into three groups, viz. – Group A (N=9)- consist of control group received conventional physiotherapy exercise intervention; Group B (N=9) – received electromyography (EMG) biofeedback exercise intervention and Group C (N=10) – received isokinetic exercise intervention. Group wise respective intervention trainings were imparted for 20 sessions (45-60 min.s /day; 2 days/ week for 10 weeks). Post-term analyses on all of the variables assessed in the pre-intervention phase were done on all of the cases after the completion of 10 weeks of intervention. Findings of this present study clarified that, although all of the interventions had beneficial impacts, EMG biofeedback intervention was observed as most effective in enhancement of muscle potentiality, while conventional exercise also was observed as having satisfactory outcomes. Further to that, compared to other intervention techniques, EMG biofeedback was also observed as mostly suitable in modulating fatigability in the subjects while Isokinetic training also were observed to have slight improvement in fatigue management. EMG biofeedback was also observed to improve in peak torque; while Isokinetic intervention was not at all beneficial for improvement in peak torque.

ABSTRAK

Kajian ini telah dijalankan dengan tujuan untuk membandingkan keberkesanan fisioterapi konvensional, 'Electromyography (EMG) biofeedback' dan senaman 'isokinetik' kepada pesakit yang menderita 'Osteoartritis' (OA) lutut. Dua puluh lapan kes 'osteoartritis' lutut dari Hospital Universiti Sains Malaysia (HUSM), berusia lebih dari 50 tahun terlibat di dalam kajian ini. Semua kes telah dinilai dengan boring soal selidik 'Western Ontario And Mcmaster Universities Arthritis Index' (WOMAC), 'Peak Torque' menggunakan Biodex 4 mesin isokinetik, 'Standing force' dan 'Knee Joint Force' menggunkan perisian 'Force Platform And 3Dimensional (3D) Qualisys Track Manage', aktiviti pengaktifan otot menggunakan 'electromyoghaphy' (EMG). Penilaian ini dilakukan untuk ujian penilaian pengukuran awal. Selepas itu mereka telah dibahagikan secara rawak dan dikategorikan kepada tiga kumpulan, iaitu. - Kumpulan A (N = 9), kumpulan kawalan, yang diterima senaman konvensional fisioterapi; Kumpulan B (N = 9), yang diterima senaman 'Electromyography' (EMG) biofeedback dan Kumpulan C (N = 10), menerima senaman isokinetik. Kumpulan tersebut masing-masing menjalani sesi senaman untuk 20 sesi (45-60 min.s / hari, 2 hari / minggu selama 10 minggu). Selepas selesai 10 minggu (20 Sesi) ujian penilaian pengukuran semula dilakukan mengikut ujian penilaian awal. Hasil daripada kajian ini kesemua jenis senaman yang dilakukan menunjukkan penambahbaikkan dari segi penilaian awal dan selepas kajian. Walaubagaimanapun senaman 'EMG biofeedback' menunjukkan keputusan peningkatan ketara berbanding yang jenis senaman konvensional fisioterapi dan isokinetik di dalam keputusan aktiviti potensi otot. Konvensional fisioterapi hanya menunjukkan keputusan memuaskan. Selain daripada itu 'EMG biofeedback' di lihat sebagai senaman paling berkesan bagi modulasi keletihan otot berbanding senaman konvensional fisioterapi dan isokinetik. Senaman isokinetik dilihat memberi impak memuaskan di dalam modulasi keletihan otot. 'EMG biofeedback' juga menunjukkan kedan positive peningkatan terhadapat keputusan 'Peak Torque', berlainan pula dengan senaman isokinetic tidak menunjukkan sebarang keberkesanan terhadap peningkatan 'Peak Torque'.

CHAPTER I

INTRODUCTION

1.1 STUDY BACKGROUND

1.1.1 Osteoarthritis (OA)

Osteoarthritis (OA) is caused by cartilage degeneration leading to pain and abnormal joint function. It is characterized by the breakdown of articular cartilage and subchondral bone within any joint. This dynamic pathological process involves all of the tissues within the synovial joint and leads to pain, stiffness, dysfunction, and disability (Fransen et al., 2008). Based on World Health Organization (WHO) in 2015, OA most likely affect the joints and continue cause stress to joint throughout the year. Joints include knee, hips, finger and lower spine joint region. Compared to all other joint diseases, osteoarthritis is found to affect more people (Buckwalter & Martin 2006).

Prior to 1986, there is no standard definition of OA (Brandt et al., 2003). During that area, OA was described as a disorder of unknown aetiology that primarily affects the articular cartilage and subchondrol bone in contrast to rheumatoid arthritis. In the same year, Subcommittee on Osteoarthritis of American College of Rheumatology Diagnostic and Therapeutic Criteria committee gave definition of OA, which is a heterogeneous group condition lead to joint symptom and signs associated with the defective integrity of articular cartilage. According to these committees OA was divided into two forms localized and generalized. In further study, OA was classified into two groups which are primary forms (idiopathic) and secondary forms, as to recognize the causative factors (Brandt et al., 2003).

Osteoarthritis is a leading cause of pain and disability across the globe (World Health Organization 2002). Francen et al., (2011) stated that the percentage of aged people (65 years and above) in Asia will more than double in the next two decades, from 6.8% in 2008 to 16.2% in 2040. Similarly, Kinsella et al., (2009) mentioned that in the year 2040, aged people (65 years and above) in Malaysia will increase by 269 %. A survey of 2594 Malaysians by the Community - Oriented Program for the Control of Rheumatic Diseases (COPCORD) found out that 20 % of males and 30% of females had knee pain and 6% of males and 10% of females had osteoarthritis of knee (Veerapen et al., 2007)

Osteoarthritis is a disease which causes a huge burden on the population. The burden of osteoarthritis is measured by direct costs, indirect costs and intangible costs. Direct costs are usually attributed to the various forms of treatment, indirect costs arises due to reduced employment, reduced productivity, absenteeism and premature mortality. The main attribute for intangible costs are pain, fatigue, activity limitation and decreased quality of life (Hunter et al., 2014). The reason for including osteoarthritis as a major focus in the global initiative – decade of bone and joint disease is due to the increasing prevalence of the disease and the consequence of osteoarthritis (Brooks PM 2002). Patients with osteoarthritis reported more severe handicap than rheumatoid arthritis (Carr 1999). OA patients reported handicap in 6 areas namely body image, emotional well-being, socioeconomic status, relationship, functional and social activities (Carr 1999).

Based on American College of Sport Medicine (2010), the common signs and symptoms of osteoarthritis is the feeling of pain during using the different joints of the body. Patients experienced a short-term stiffness which is less than 30 minutes and gelling in inactive joints which is stiffness for several minutes. The present of osteophytes or bone hyperthrophy, cartilage destruction, joint malalignmnet and ligament and tendon laxity are also signs of OA. Not only that, patient may also have movement or gait problems, muscle weakness. Thus, causes limitation of muscle activity and increasing pain during activity.

A conceptual model for pathogenesis of OA consist of three main area which is a biomechanical organ system that maintains proper movement and preventing excessive loading such as ligaments, cartilage, bone, muscle and tendon. The second area is systemic factors (age, gender, sex hormone, bone mineral density and osteoporosis, nutrition, ethnicity and race and genetics) which may increase overall susceptibility to joint degeneration and local mechanical factors (obesity, acute injury and repetitive joint loading, joint deformity as well as muscle strength and weakness) that may impair the optimal function of joint. Last but not least the interaction of systemic and mechanical factors operating to determine joint development and disease progresses (Arden and Cooper, 2006). Age and gender (female) are directly proportional to the prevalence of osteoarthritis. 40% of the people above an average age of 65 years are having symptoms of arthritis while 30% of them present with radiographic changes (Lachance et al., 2002). Disability in knee osteoarthritis occurs due to muscular weakness, decrease or loss of range of motion and chronic joint pain (Lewek, Rudolph and Snyder 2004).

1.1.2 Exercise Intervention for Osteoarthritis

Osteoarthritis (OA) together with rheumatoid arthritis (RA) and fibromyalgia syndrome (FM) is most comman form of arthritis which has no cure. Each of the condition can be medically and pharmacologically manage. Management such as surgery, patient education programme including exercise, nutritional counselling and behaviour modification technique as well as conventional physiotherapy, electromyography biofeedback and isokinetic exercise intervention are beneficial therapeutic management program for the OA patient (Deyle et al., (2005) ; Yilmaz et al., (2010) ; Huang et al., (2005). Facts that arthritis leading to disability in patient therefore, patient are educate to involved in therapeutic treatments especially exercise. It may help them manage their disease and decease the levels of disability. In general rehabilitative exercise has shown to have significant impact on decreasing the impairment and disability in arthritis (ACSM, 2010)

1.1.2.1 Conventional Physiotherapy

Conventional physiotherapy encompasses a number of treatment modalities which includes electrotherapy, exercise therapy, aquatic therapy, manual therapy, knee taping and patient self-education. American college of rheumatology and European league against rheumatism recommend physiotherapy as non-pharmacological intervention for knee osteoarthritis (Jordan et al., 2003; American College of Rheumatology 2000). Strong evidence supports the beneficial effects of physiotherapy in any form over pain and knee function. Provision of knee braces and lateral wedge shoe insoles are effective in reducing the knee load (Page, et al. 2011). To maintain the benefits of exercise in osteoarthritic patients long term adherence to exercise is important. Regular Motivation, supervision and monitoring is a major requirement for long term adherence (Hillsdon et al. 2005). Electrical stimulation of quadriceps muscle improves the strength of the muscle (Selkowitz 1985).

Active exercise program such as strength training, aerobic activity and range of motion exercise should be included in physiotherapy or manual therapy for patients with osteoarthritis of knee (Jansen et al., 2011). Most of the reviews performed have remained inconclusive on the exercise regime ideal for the osteoarthritic patients

1.1.2.2 Electromyography (EMG) Biofeedback

EMG-biofeedback defined as the technique of using equipment to reveal to human beings some of their internal physiologic events, normal and abnormal, in the form of visual and audible signals to teach them to manipulate these otherwise involuntary or unfelt events by manipulating the displayed signals (Basmajian 2005). The electrical activity of muscle are detected and amplified by electromyography biofeedback. Visual and auditory cue about the magnitude of the muscle is provided to the patients using biofeedback. Greater voluntary control by means of either neuromuscular relaxation or re-education of muscle after injury is obtained by the use of EMG biofeedback (Prentice 2005). Motivation and compliance to exercise are supposed to increase if the exercise programs are assisted by EMG-biofeedback. The effect of exercise improves following EMG biofeedback (Levitt 1995). Temporomandibular joint disorders, facial palsy, headaches due to tension, incontinence and constipation are some of the crises in which EMG biofeedback are commonly used (Enck et al., 2009; Nestoriuc et al.,2009; Cardoso et al., 2008; Crider et al., 2005). EMG biofeedback has been suggested to affect the neuromuscular system at the level of cortex (Croce 1986).

1.1.2.3 Isokinetic Training

Recently Isokinetic dynamometer are used to assess and improve muscle function in both rehabilitation and training but the concept of isokinetic exercise began in late 1960s (Miller et al., 2006). Human muscles produce alternate isometric tone and auxotonic contractions as well as isotonic contractions (Musculino et al., 2012). Isokinetic training consists of training at a constant velocity with changes in muscle length and tension. Isokinetic exercise is a kind of dynamic exercise, characterized by relatively constant speed of movement. Under isokinetic conditions, muscle activity may be both concentric and eccentric. It may also involve alternate concentric–eccentric or eccentric–concentric contractions. Under isokinetic conditions, exercises may be performed in open or closed kinematic chain (Dvir et al., 2004; Davies et al., 1992).

Measurement under isokinetic conditions is one of the methods allowing us to obtain objective data on peak torque (PT) values and the average strength, expressed in newton meters (Nm) produced by the muscle groups studied. Relative torque (RT) is an indirect value, calculated from the value of torque per one kilogram of body mass (Nm/kg bm). It also measures muscle work expressed in joules (J). The measurement determines peak torque angle, expressed in degrees (°), the preset angular velocity, expressed in degrees per second (°/s), power, expressed in watts (W) and many other parameters, obtained or calculated. The measurements performed under isokinetic conditions allow us to determine the deficit in the values of the biomechanical parameters obtained that can be compared to that obtained for the uninvolved extremity (Reichard et al., 2005; Dvir et al., 2004). Gait velocity and muscle strength of stroke patients improves after short term isokinetic training (Sharp and Brouwer 1997). Maximal intensity force is exerted throughout the range of movement during isokinetic exercise training.

1.2 SIGNIFICANCE OF THE STUDY

Osteoarthritis is an ongoing problem which create burden for the elder people. This burden can reduce the ability of the aged person which hampers their daily life. Treatment of OA is sometime very expensive and there are no conclusive report regarding the benefit of different types of therapeutic program. The present study was done in order to provide evidence regarding the techniques that is superior to other which can help in the improvement of muscle strength and function of knee in persons suffering from osteoarthritis of knee. The scientific evidence from this present study may help OA knee patient and the therapists to select the suitable intervention by comparing the differentiation in intervention efficacy, availability and cost of the treatment.

1.3 OBJECTIVE OF THE STUDY

1.3.1 General Objective

To compare the effectiveness of conventional physiotherapy, electromyography (EMG) biofeedback and isokinetic exercise intervention on person suffering osteoarthritis (OA) of knee.

1.3.2 Specific Objective

1) To identify the effect of conventional physiotherapeutic exercise intervention on person suffering osteoarthritis (OA) of the knee.
2) To identify the effect of electromyography (EMG) biofeedback exercise intervention on person suffering osteoarthritis (OA) of the knee.
3) To identify the effect of isokinetic exercise intervention on person suffering osteoarthritis (OA) of the knee.
4) To compare the effectiveness of conventional physiotherapy, electromyography (EMG) biofeedback and isokinetic exercise intervention on person suffering osteoarthritis (OA) of knee.

1.4 RESEARCH HYPOTHEISIS

1.4.1 Null Hypothesis (Ho)

1) No significant effect of conventional physiotherapy exercise intervention on person suffering osteoarthritis (OA) of the knee would be expected.
2) No significant effect of electromyography (EMG) biofeedback exercise intervention on person suffering osteoarthritis (OA) of the knee would be expected.
3) No significant effect of isokinetic exercise intervention on person suffering osteoarthritis (OA) of the knee would be expected.
4) No difference in the efficacy of conventional physiotherapy, electromyography (EMG) biofeedback and isokinetic exercise intervention on person suffering osteoarthritis (OA) of knee would be expected.

1.4.2 Alternative Hypothesis (H_A)

1) Significant effect of conventional physiotherapy exercise intervention on person suffering osteoarthritis (OA) of the knee would be expected.
2) Significant effect of electromyography (EMG) biofeedback exercise intervention on person suffering osteoarthritis (OA) of the knee would be expected.
3) Significant effect of isokinetic exercise intervention on person suffering osteoarthritis (OA) of the knee would be expected.
4) Significant difference between the efficacy of conventional physiotherapy, electromyography (EMG) biofeedback and isokinetic exercise intervention on person suffering osteoarthritis (OA) of knee would be expected.

CHAPTER II

REVIEW OF THE PREVIOUS LITERATURE

The studies that have been reviewed can be broadly classified into

i) Those concerned to identify the effects of physiotherapy on osteoarthritis.

ii) Those concerned to know the effect of Electromyography biofeedback on osteoarthritis.

iii) Those concerned to know the effect of isokinetic training on muscle function.

The main parameters or variables related to osteoarthritis that would be discussed in this review would be on muscle function and functional outcomes of the knee joint .The review of literature is structured on the following headings -

i) Effect of conventional physiotherapy on osteoarthritis;

ii) Electromyography biofeedback (EMGBF) and quadriceps muscle function;

iii) Impact of EMGBF on osteoarthritis;

iv) Isokinetic training and muscle function.

2.1 EFFECT OF CONVENTIONAL PHYSIOTHERAPY ON OSTEOARTHRITIS

This part of review focuses on the effect of various exercises on patients with osteoarthritis of knee. Dalhberg et al., (2003) found out the glycosaminoglycan (GAG) content increases in persons who exercise on a regular basis. Resistance to mechanical compression is increased by GAG and also it protects the collagen network and prevents the development of osteoarthritis. Helmark et al., (2010) found out that exercise increases interleukin IL -10 levels which is of chondroprotective in nature. In a Cochrane review done by Bartels et al., (2007) where it was found that aquatic exercises reduce pain, functional disability and improves the quality of life. In a randomised controlled trial with 16 participants Krasilshchikov et al., (2011) observed the comparative impacts of progressive combined resistance and aerobic exercise, and reported improvement in WOMAC scores; knee extensor peak torque in aerobic capacity and walking ability as well. In a comparative study between progressive resisted exercise and closed kinetic chain exercise on patients (n = 30) with osteoarthritis of knee, Ozdincler et al., (2005) reported that closed kinetic chain exercises increases the muscles strength and functional performance of patients. Deyle et al., (2000) in a randomised controlled trial on 83 patients with osteoarthritis who underwent manual therapy and exercise reported reduction in severity of pain and increase in walking distance after the cessation of intervention. Tuzun et al., (2004) in a comparative study between isotonic and isokinetic exercises on 62 subjects reported decrease in pain and Western Ontario and Macmaster university osteoarthritis index (WOMAC). All the researches mentioned have substantiated that exercise in any form helps in preventing or delaying the onset of osteoarthritis and its worsening.

Likewise, Mei-Hwa Jan et al,. (2009) investigated the effects of weight bearing versus non weight exercise on function, walking speed and position sense in patients with knee osteoarthritis. A group of 106 patients were recruited and randomised into three groups undergoing weight bearing exercises, non -weight bearing exercise and control group. The groups underwent training for 3 sessions per week for 8 weeks. WOMAC score, walking speed, muscle torque and reposition error were recorded pre and post-test. The researchers reported that non weight bearing exercises are sufficient enough to improve the function and muscle strength.

Similarly, Lin et al., (2009) studied the effect of non-weight bearing proprioception training and strength training in 108 patients with osteoarthritis of knee. Lin et al., (2009) identified that both non weight bearing proprioceptive and strength training programmes improved the outcomes (WOMAC, walking time, and knee strength and repositioning error). In a randomised clinical trial by Topp et al., (2002), investigated the effect of dynamic versus isometric resistance training on pain and functioning in adults with osteoarthritis of knee, where Topp and his colleagues performed isometric strength training exercises for a group of 32 subjects and dynamic exercises for another group of 35 subjects and compared it with a control group of 35 subjects. They performed the exercises for 3 sessions per weeks for 16 weeks. Topp and colleagues (2002) found out that both the groups improved significantly when compared to control group. They also reported that isometric and dynamic resistance training improves the functional ability and reduces knee joint pain in patients with osteoarthritis. Coleman et al., (2012) argued that a simple self-management program for patients with osteoarthritis provided for a period of 6 weeks is sufficient enough to improve the quality of life, functional ability and reduction of pain in a group of 71 patients who underwent self- management program compared to that of a control group of 75 patients who underwent a regular management program. Most of the studies mentioned above have reported the beneficial effect of exercise on osteoarthritis.

2.2 ELECTROMYOGRAPHY BIOFEEDBACK (EMGBF) AND QUADRICEPS MUSCLE FUNCTION

The effects of electromyography biofeedback and its effect on quadriceps muscle function will be reviewed in this section. Electromyography biofeedback has been used as an adjunct to exercise program in various orthopaedic crises of knee. Researchers have been using EMGBF to aid in the recovery of quadriceps muscle function. Anwer et al., (2013) conducted a randomised controlled trial to find out the effectiveness of electromyography biofeedback along with isometric quadriceps exercise on patients with osteoarthritis of knee. He recruited about 33 patients (10 men and 23 women) and performed EMGBF along with isometric quadriceps exercise for a group (n=17) and the control group received only exercise program (n=16). The intervention was given for 5 days a week for 5 weeks. At the end of the fifth week Anwer et al., (2013) reported a significant improvement in the quadriceps strength in the EMGBF group. Similar findings were also observed by Draper (1990) after a 12 weeks exercise program using Electromyographic biofeedback on patients who underwent anterior cruciate ligament reconstruction of knee joint. But this finding was contradicted by Durmus et al., (2007).The researcher conducted a trial on about 50 patients with osteoarthritis of knee. The researcher administered electrical stimulation for one group and biofeedback to other group for 5 days a week for 4 weeks. At the end of the trial the researchers reported that electrical stimulation of quadriceps is as effective as biofeedback exercise for osteoarthritis.

Yip and Ng (2005) found out that isokinetic knee extension strength of patients suffering from patellofemoral pain syndrome increased due to both Electromyography biofeedback and exercise program performed at home by the patients themselves. They compared the efficacy of EMGBF on a group of patients (n=26) with patellofemoral pain syndrome by administering home exercise program for a group and EMGBF for another group for a period of 8 weeks. When the results were compared between the two there was no significant difference. On the other hand, Adamovich et al., (1979) investigated the effect of EMGBF on isometric contraction of quadriceps. The control group performed exercises on an isokinetic device whereas the experimental group received visual and auditory EMGBF while exercising. The experimental group had significantly greater gains in strength when compared to control group.

The effect of EMGBF was also investigated by Sprenger et al., (1979) on patients who underwent meniscectomy and anterior cruciate ligament (ACL) repair. They performed an EMGBF on vastus medialis of a patient with a limitation of range of motion of knee and found out that the activity of vastus medialis and active range of motion. The findings of Akkaya et al., (2012) were found to support the findings of Sprenger et al.,(2013). Akkaya et al., reported that addition of EMGBF to regular exercise program for a patients who underwent arthroscopic meniscectomy (n=45) reduces the time using walking aid. They also reported that EMGBF increased the recovery of quadriceps muscle power after the surgery.

2.3 ELECTROMYOGRAPHY BIOFEEDBACK (EMGBF) ON KNEE OUTCOMES IN OSTEOARTHRITIS

This part of the review is intended to find out the previous literatures available on EMGBF and its effect on the knee outcomes. Akkaya et al., (2012) when investigating the effect of EMGBF on the knee functional outcomes over 45 patients who underwent arthroscopic meniscectomy found that there was no difference in pain between the experimental group and control group. When the Lysholm Knee Scoring Scale compared between the groups, the EMGBF groups score was found to be better only after 2nd post-operative week. Kirnap et al ., (2005) found the Lysholm knee scores of 20 patients (mean age 34.5±10.3) with arthroscopic meniscectomy who underwent EMGBF was found to be significantly better than the other 20 patients who underwent a regular exercise program. But when considering the population with osteoarthritis the effect of EMGBF is controversial. Durmus et al., (2007) found no difference in Visual Analog Scale (VAS) and WOMAC score between in EMGBF and the control group after 4 week. Durmus et al., (2007) rechecked the effects of electrical stimulation of quadriceps on clinical parameters of patients with knee osteoarthritis. About 50 osteoarthritic patients were recruited for the research and randomised into two groups, each group of 25 patients. One group was exposed to electrical stimulation and other group for EMGBF. Both groups were treated for 20 mins duration, five times a week for 4 week. In yet another research by Yilmaz et al.,(2010) the visual analog scale and WOMAC score of 40 osteoarthritis patients who underwent EMGBF and strengthening exercise separately and together were found to be equal. There was no significant additive effect of EMGBF over strengthening exercise. Christanell et al., (2012), Yip and Ng (2006), Dursun et al., (2001) and Levitt et al., (1995) did not find any significant differences in pain scale and functional outcomes between EMGBF and regular exercise.

2.4 ISOKINETIC TRAINING AND MUSCLE FUNCTION

Studies related to isokinetic training, muscle function and its effect on osteoarthritis will be discussed in this part of the review. Lesmes et al., (1978) investigated the effects of short duration and high intensity training on skeletal muscle. Isometric peak torque were measured for knee flexors and extensors at velocities ranging from 0 deg/sec to 300 deg /sec .total work output was measured for work task of 6 second and 30 second duration. Subjects were trained for four times per week for a period of seven weeks. Lesmes et al., (1978) found out that isokinetic training programs of 6 and 30 second duration significantly improves the peak torque, training velocity is an important factor to be considered and total work output increased at both slow and fast velocity.

In another study performed by Higbie et al., (1996) to observe the effects of concentric and eccentric training on muscle strength, cross- sectional area and neural activation on sixty women with age ranging from 18-35 years found out that both concentric and eccentric training improves muscle strength and muscle hypertrophy occurs more in eccentric training than concentric training. Akyol et al., (2010) recruited about 40 women for a randomised controlled trial to find out whether shortwave diathermy can increase the effectiveness of isokinetic exercise on pain, function, muscle strength quality of life and depression in patients with knee osteoarthritis. A group of 20 women received shortwave diathermy and isokinetic exercise and another group of 20 women served as control group receiving only isokinetic exercise. Both groups underwent training for 3 days a week for 4 weeks. All the subjects were assessed at baseline, after 4 weeks and at three month follow up. The researcher reported that isokinetic training program is effective in improving the muscle strength and quality of life in patients with osteoarthritis of knee.

Huang et al., (2003) in a randomised controlled trial with 132 subjects who was exposed to isokinetic, isometric and isotonic exercise on muscle strength found out that isotonic exercise decrease pain and improve strength. Isokinetic exercises improve the walking speed and muscle strength of the participants. Salli et al., (2010) found out that isometric exercise and isokinetic exercise for osteoarthritic patients improved the range of motion, muscle strength and decreased pain. The same findings were also reported by Rosa et al., (2012). The researcher also pointed out that isokinetic and isometric exercise increases the range of motion and muscle strength.

Jegu et al., (2014) investigated the effect of isokinetic strengthening in the rehabilitation of patients with knee osteoarthritis on 80 subjects aged between 40 and 75 years. A group of 40 patients underwent eccentric isokinetic training and another group of 40 subjects underwent concentric isokinetic training at 60°/sec and 180°/sec in concentric mode and 30°/sec in eccentric mode for two times a week for 6 weeks with a minimum of 1 day rest between sessions. The measurements of quadriceps and hamstring muscle strength, functional status, range of motion and pain were done at baseline, 6 weeks and 6 months. It was found out that isokinetic strength training produce a faster rate of strength gain and reduce muscle tenderness. The researcher also stated that priority could be given to an eccentric training in rehabilitation of patients with knee osteoarthritis. Gur et al., (2002) also reported similar findings suggestive of isokinetic training improving the functional capacity and decreasing pain in patients with osteoarthritis of knee. It was also reported that high number of repetitions and eccentric contractions was safe and well tolerated by patients with osteoarthritis of knee. Wojtys et al., (1996) in his work on neuromuscular adaptations in Isokinetic, Isotonic and agility training programs reported that the agility trained group significantly improved the muscle reaction time compared to isokinetic and isotonic training. Philips and Hazeldene (1996) concluded that maximal isokinetic training at 60°/sec three times per week for 12 weeks increased the strength of knee musculature of elderly male subjects. Research findings have so far indicated that isokinetic training have found to improve the muscle strength of quadriceps and hamstring but its superiority over other forms of exercise training remains controversial.

2.5 SUMMARY OF THE LITERATURE REVIEW

The previous literature review shows a beneficial of exercise effectiveness on patient suffering OA of knee, but there are few researches shows contradictory results. The contradiction of the result may resulted from differences of methodology or protocol that been carried out, such as intervention duration, methods used and population differences. The present study was carried out in order to minimized and understands the reason behind the contradiction by comparing different exercise interventions.

CHAPTER III

METHODOLOGY

PART-A

GENERAL METHODOLOGY

A.1 INTRODUCTION

In this present study, osteoarthritis knee participant was assessed by using four methods. Each method contributes for different type of reliable parameter for this study. There are Westren Ontario and McMaster Universities Arthritis Index (WOMAC) questionnaire, Biodex 4 Multi Joint Isokinetic Machine, Force Platform with 3D Qualisys Track Manager (QTM) and Electromyography (EMG) Mega ME6000 Biomonitor. WOMAC questionnaire was used as subjective subscale for pain, stiffness and physical function assessment. Biodex 4 multi joiny isokinetic machine was used for identify peak torque of quadriceps muscle. Force platform and 3D qualisys track manager was used for determined force, centre of pressure and force of knee joint of patient having osteoarthritis of the knee. Electromyography (EMG) Mega ME6000 biomonitor is used to identify electrical activation of muscle.

A.2 WESTERN ONTARIO AND MCMASTER UNIVERSITIES ARTHRITIS INDEX (WOMAC)

A.2.1 Introduction

The Western Ontario and Mcmaster Universities Arthritis Index (WOMAC) questionnaire was developed by Nicholas Bellamy in year 1982. (American College of Rheumatology, 2002) . The questionnaire has been extensively used, not only in observational, epidemiology as well as to determine changes after treatment. It is widely used in pharmacotherapy, arthroplasty, exercise, physical therapy, knee bracing and acupuncture research. The WOMAC questionnaire is patient-centred self-report suitable to indicates health status of patient with osteoarthritis with various part mostly osteoarthritis of knee. WOMAC questionnaire been used widely since 1982 and validity, reliability and responsive research have been done for more than 17 years. WOMAC questionnaire are easy to complete and index has been extensively validated and has been translated and linguistically validated in over 65 alternate-language forms. The questionnaire provide researcher to be able in capturing patient relevant data and relating to the impact of interventions (Bellamy,2005)

In WOMAC questionnaire, there are 24 parameters index within three subscales. All questions were set to notified pain, stiffness and physical function within 48 hours before answering the questionnaire. There is no time limitation to answering the question. Approximately 12 minutes are requiring for each participant to complete the questionnaire. It is available in 5-point Likert scale. The response categories are none, mild, moderate, severe and extreme description item. The item is corresponding to an ordinal scale of 0, 1, 2 and 4. Before participant begins to answer, researcher reminds and explains to the participant about differences of three subscales (pain, stiffness and physical activity). Participants are allowed to ask question for more understanding in each item.

A.2.2 Analysis of Data

The possible range of score for each pain subscale is 0 to 20, stiffness subscale 0 to 44 and physical function is 0 to 32. Total possible range of score is 0 to 96.

A.2.3 Interpretation of Data

In WOMAC questionnaire, the highest of the score indicates the higher level of problem in osteoarthritis. Comparison between pre and post intervention will determined the effectiveness type exercise following participant self-report.

A.3 ISOKINETIC BIODEX 4 MULTI-JOINT SYSTEM

A.3.1 Introduction

Isokinetic development started in late 1960's that converse traditional exercise by controlling fixed weight with variable speed, fixed speed with variable resistance and safer form of rehabs. Isokinetic Biodex 4 consist of monitor, system 4 CDS cart , five multi-joint power system cord connections, chair , dynamometer control and adjustment, and multi-joint system accessory cart which include position attachment . The research used only right and left knee attachment.

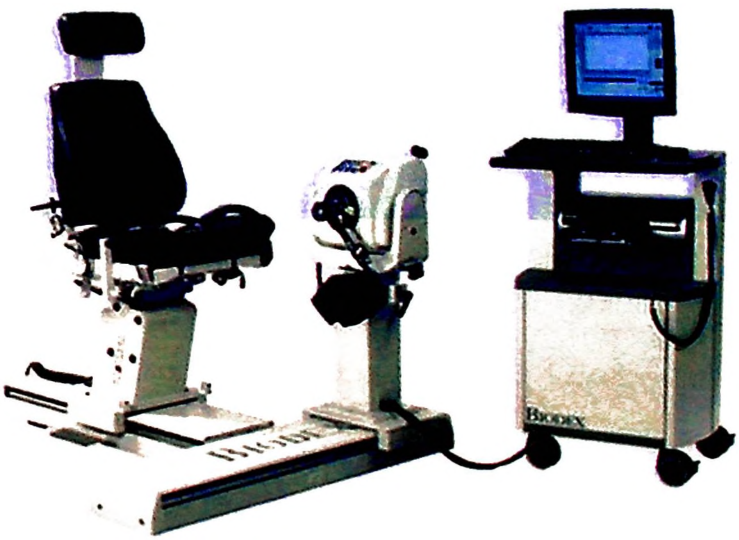
A.3.2 Analysis of Data

Research participants were required to perform knee extension with given resistance and repetition with similar speed. Numerical data of peak torque were extracting from Biodex 4 software system.

A.3.3 Interpretation of Data

Peak torque numerical data were extracting from the system with Neuton-meter (Nm) unit for identifying quadriceps muscle power of participants. The data were used for comparing effectiveness of each participant in same group as well as among 3groups before and after intervention weeks. Increasing in peak torque of affected leg may shows effectiveness of the intervention.

Figure 1 : Isokenetic Biodex 4 Multi Joint System



A.4 FORCE PLATFORM AND 3D QUALISYS TRACK MANAGER

A.4.1 Force platform

A.4.1.1 Introduction

Bertec Corporation been producing a lot of force plate model specifically design for gait, balance, sport and other static and dynamics analyses. Bertec's force plates are well suited for both static and dynamic application with the used of strain gouge technology, innovative design m and quality manufacturing. Strain gouge load transducer and built-in digital pre-amplifier in each force plates were used for signal conditioning. Variety of force plates were built to suite different application needs. The 6090, 9090, 6012 series force plates are well suited for rigor of sports and other dynamic biomechanics, ergonomics and industrial research. The rugged honeycomb technology used for the production of the tops and bases ensure enhanced dynamics measurement characteristics while keeping the overall weight to a minimum.

Bertec's force plates are six-component load transducers, which measure the three orthogonal components of the resultant force acting on the plate, and the three components of the resultant moment in the same orthogonal coordinate system. The point if application of the force and the couple acting on the plate can be readily calculated from the measured force and moment components.

Bertec's force plate uses a state-of-the-art 16-bit digital technology for signal acquisition and conditioning which useful for calibration matrices obsolete. External amplifiers to be used with force plates provide with three signal output alternative which are digital analog or dual digital/analog output. Bertec's force plates can be used with any type of motion analysis system ranging from camera-based system using passive marker to system with active markers or magnetic sensor.

Force plate system made of force plate, mounting plate, cable, amplifier connection and computer. Mounting plate is used in order to fix the force plate to the floor. Mounting plate is 19mm thick and has the same dimension as force plate. It comes with pre-tapped holes that used to anchor locations on the feet of the force plate to the floor. Data collections are transfer via cable connection with external amplifier and computer for analyses.

A.4.1.2 Analysis of Data

16-bit digital technology are used for signal acquisition and conditioning. The output signal of the load transducer were digitized and conditioned in the force plate by using electronic technology made by Bertec's Corporation. The digital output form in respective unit newton (N) or newton-meter (Nm). Force and centre of pressure (COP) were taken during stance position. Knee joint force was taken during walking with opposite leg toes off.

A.4.1.3 Interpretation of Data

Increasing force may show effectiveness of the intervention.

A.4.2 3Dimensional Qualisys Track Manager (QTM)

A.4.2.1 Introduction

Qualisys Track Manager, or QTM for short, is Qualisys' main software that handles the motion capture process. The software is an integral part of Qualisys' motion capture system with additional Visual 3D analyser, this application were used widely in difference scenario. It can be used indoor or outdoor, in-air or underwater. The existence of passive markers or active markers, real-time or post-processing, ensuring a consistent and familiar user experience.

Technology in biomechanics used in core of Visual 3D as Model Builder. Biomechanical modelling tools were used to define an unstricted number of rigid segment and link them together. Visual3D model defines each joint as generalized six degree of freedom modelling technique with optimal method for tracking segment of the model. This allows the analysis of virtually any human, animal or mechanical movement. The pose (position and orientation) of each segment is determined by 3 or more non-collinear points attached to the segment.

Qualisys Track Manager, Visual 3D Tm Basic/Rt 3D Motion Analysis Analyzer was made from Qualisys Track Manager Software and Oqus camera system. Oqus camera system used 6 camera system which include 1 host cable between computer and camera, 4 bundle hybrid cables power and data , 2 power supply for camera, host cable and markers . There are six connectors for power, data and control connection in the back of each camera. Markers are used as building modelling by linking them in one another.

There were 37 markers placement attachment in participant body. 13 markers in each left and right leg while one marker at sacrum. 13 markers were place at anterior superior iliac spine (ASIS), inferior superior iliac spine (ISIS), greater trochanter,4 markers for thigh, lateral epicondyle of knee, medial epicondyle of knee, 4 markers for shank, lateral ankle, medial ankle, heel, 1st metatarsal head and 5th metatarsal head. `

A.4.2.2 Analysis of Data

Data analysis was made after tracking marker and bone building model. The flexion/extension, abduction/adduction and longitudinal rotation were analysing as X, Y and Z axes. The knee force were been analyse before and after 10 weeks intervention.

A.4.2.3 Interpretation of Data

Data were collected and calculated by the system. The data were used for comparing effectiveness of each participant in same group as well as among three groups intervention between before and after intervention weeks. Moreover, relation among parameter were compared and the data were used in order to notify are relation among this method with other method. Increasing knee force may shows effectiveness of the intervention.

Figure 2: Force platform and 3Dimensional Qualisys Track Manager (QTM)