International Journal of Research and Review
Vol.7; Issue: 4; April 2020
Website: www.ijrrjournal.com
Original Research Article *E-ISSN: 2349-9788; P-ISSN: 2454-2237*

Effectiveness of Eccentric Exercise and Neuromuscular Electrical Stimulation on Quadriceps Function in Grade II Osteoarthritis- A Randomized Control Trial

Suraj Mathew[1], Kiran Janbandhu[2], Pradeep Borkar[3]

[1]Post Graduate Student, VSPM's College Of Physiotherapy, Nagpur, Maharashtra, India
[2]Asst. Professor. VSPM's College Of Physiotherapy, Nagpur, Maharashtra, India
[3]Asst. Professor. Dr. APJ Abdul Kalam College Of Physiotherapy, Loni, Maharashtra, India

Corresponding Author: Suraj Mathew

ABSTRACT

Background: Osteoarthritis is amongst the most common musculoskeletal condition which affects overall function and quality of life in Indian population. Clinical features of knee osteoarthritis include pain which affects functional mobility of joints and thus interferes with walking and activities of daily living. Quadriceps function declines with age, and is further impaired in patients with knee and may contribute to risk of fall. The Aim of the present study was to find the effectiveness of eccentric exercise and Neuromuscular Electrical Stimulation on quadriceps function in grade II osteoarthritis.

Objectives: To find the effect of eccentric exercise and Neuromuscular Electrical stimulation on quadriceps Isometric strength in grade II osteoarthritis. To find the effect of eccentric exercise and Neuromuscular Electrical Stimulation on pain and disability in grade II osteoarthritis.

Methodology: Permission from the head of institution and approval from the ethical committee were obtained. Patients pre-diagnosed with Grade II OA were selected for this study. Consent was taken from the patients after confirming the diagnosis of Grade II OA. The subjects were divided into two groups. One group consisted of a combination of Eccentric exercise and NMES (E+N) and the second group consisted of Eccentric exercise itself (E). Allotment of the subjects was done by Block Randomization method.

Result: Group 1 (NMES +ECC) expressed better increase in Maximum Voluntary Contraction of Quadriceps as compared to Group 2(ECC). There was an increase in walking speed in Group 1 (NMES+ ECC) compared to the Walking speed in Group 2 (ECC). The WOMAC score decreased equally in both the groups.

Conclusion: The results concluded that quadriceps muscle function showed improvement in both the groups after intervention. But the increase in quadriceps muscle function was more significant in group 1 when it was compared to group 2 post interventions.

Keywords: Osteoarthritis, Neuromuscular Electrical Stimulation, Eccentric Exercises

INTRODUCTION

Osteoarthritis is amongst the most common conditions which affect the overall function and quality of life[1]. The prevalence of OA increases with age and generally affects Females more than males. Aging and heavy physical activity is strongly associated with the condition.

Exercises strengthening the muscles, reduce pain, improve physical function, and are therefore considered a major intervention in the conservative treatment of patients with knee OA. In addition to muscle strengthening exercises, stretching exercises are commonly used to improve ROM and are often prescribed in rehabilitation

protocols as a part of routine warm up to prepare the muscles and joints for other types of exercises such as Aerobic and strengthening programs.[6] Stretching of the Hamstrings muscles may improve knee extension ROM in OA patients.[5]

When weight is exceeds than force produced by the muscle, as in an eccentric muscle action, the exercise is referred to as negative work because the muscle is absorbing energy in this loaded position.[8]

Strength of the quadriceps musculature is one of the intrinsic factors that have been shown to affect the knee joint functions. Quadriceps weakness along with Osteoarthritis is associated with reduction in functional performance. Quadriceps muscle atrophy that occurs following Grade II OA is also thought to contribute to persistent muscle weakness.[18]

As NMES exogenously stimulates the muscle, large diameter Type II muscle fibers are thought to be selectively recruited, resulting in a greater potential for muscle force production. [14]

The technique of application of NMES can also be used as a form of Physical Therapy in the treatment of patients with knee OA. The methods and findings of previous studies on the effectiveness of NMES in knee OA differ on the modulation of NMES parameters choice of outcomes used to evaluate the patients, and characteristics of the control groups. This leads to lack of consensus regarding the effectiveness attained from including NMES in conventional rehabilitation protocols.

Quadriceps weakness is a clinical sign in OA knee and weakness of quadriceps increases as duration of the condition increases. Use of NMES has shown a clinically significant effect on muscle activation. [15] Maintenance of muscle mass, stimulation and the neuromuscular level followed by facilitation and strengthening of muscles can be potential indications to NMES.

WOMAC Index Modified CRD Pune Version includes activities commonly performed by Indian population like squatting, sitting crossed leg or rising from cross leg sitting. Pain, stiffness and level of difficulty while performing these activities can be evaluated through Modified WOMAC. Thus, this outcome measure would give data regarding pain and functional disability considering Indian population.

WOMAC Index (version Likert 3.0): This functional assessment instrument, containing 24 questions is used to grade the pain, stiffness, and physical function difficulty pertaining to the knee joint. Patient's answer is graded on a qualitative scale (0 none, 1 mild, 2 moderate, 3 severe, 4 extreme). The maximum score could be 96 (pain20, stiffness 8, difficulty 68).in patients having Grade II Osteoarthritis.

NEED FOR STUDY

The demand for safe, noninvasive and non-pharmacologic treatments for management of OA is increasing as they do not give any side effects. Clinical features of knee osteoarthritis include pain which affects functional mobility of joints and thus interferes with walking and activities of daily living. Previous research concluded that quadriceps function declines with age, and is further impaired in patients with knee OA which may contribute to risk of fall and thus decrease functional mobility. [53]

The Quadriceps group is amongst the prime muscle group in the knee joint responsible for mobility and overall functioning of the knee joint. Decrease in Quadriceps function results in decrease in overall knee functioning.

There is very less evidence for the use of NMES for the treatment of Osteoarthritis. Similarly there is also very less evidence on the use of combination of NMES and eccentric exercises in the treatment. Finding whether the combination NMES and Eccentric exercises in improving the quadriceps function would provide a new and better form of intervention in the treatment of Knee OA.

AIM AND OBJECTIVES

AIM:

Effectiveness of eccentric exercise and Neuromuscular Electrical Stimulation on quadriceps functions in grade II osteoarthritis.

OBJECTIVE:

1. To find the effect of eccentric exercise and Neuromuscular Electrical stimulation on quadriceps Isometric strength in grade II osteoarthritis.
2. To find the effect of eccentric exercise and Neuromuscular Electrical Stimulation on pain and disability in grade II osteoarthritis.
3. To find the effect of eccentric exercise and Neuromuscular Electrical Stimulation on Walking speed in grade II osteoarthritis.

MATERIALS AND METHODOLOGY

- **Research design:**
- Experimental study (Pre & Post design).
- **Sampling procedure:** Simple random sampling
- **Duration of Study:** 2 years
- **Sample size:** 32 per group totaling to 64(4 Were Dropouts)
- **Study Setting –** Physiotherapy OPD of a tertiary care hospital
- **Target population:** Patients with the age of 45 years and above
- **Inclusion criteria:**
- Pre-Diagnosed case of Grade II OA patients on K L classification
- Age: 45 years & above
- **Exclusion criteria:**
- Any recent hip or knee surgeries & fractures
- Patients with neurological deficit
- Soft tissue injuries of lower limb
- Any systemic illness

STUDY MATERIAL:

1. WOMAC Modified CRD Pune Version
2. Patient Data Sheet

Equipment:

Hand held dynamometer

Neuromuscular Electrical Stimulator

Cones

Stopwatch

OUTCOME MEASURES:

1. Isometric Muscle strength (quadriceps) using hand held dynamometer (unilaterally)
2. WOMAC score
3. Walking speed

PROCEDURE

Permission from the head of institution and approval from the ethical committee were obtained. Patients pre-diagnosed with Grade II OA (Kellgren and Lawrence classification) were selected for this study. Consent was taken from the patients after confirming the diagnosis of Grade II OA. The study was explained to them in detail. The consent form was filled in the language comfortable for the patient.

Exercise Dosage:

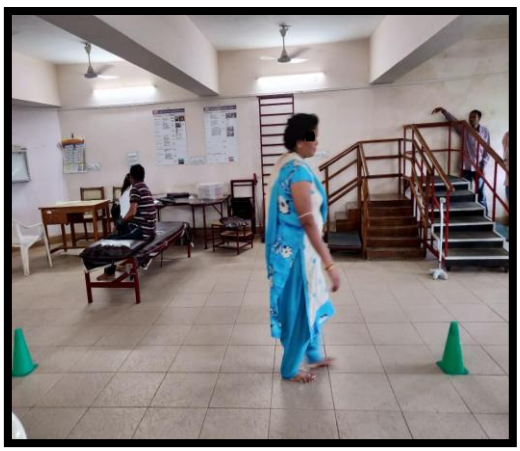
Group 1 (E+N):

7 NMES contractions of quadriceps X 2 SETS

+ 7 Eccentric repetitions x 2 SETS Group 2 (E): 7 eccentric Repetitions X 2 SETS

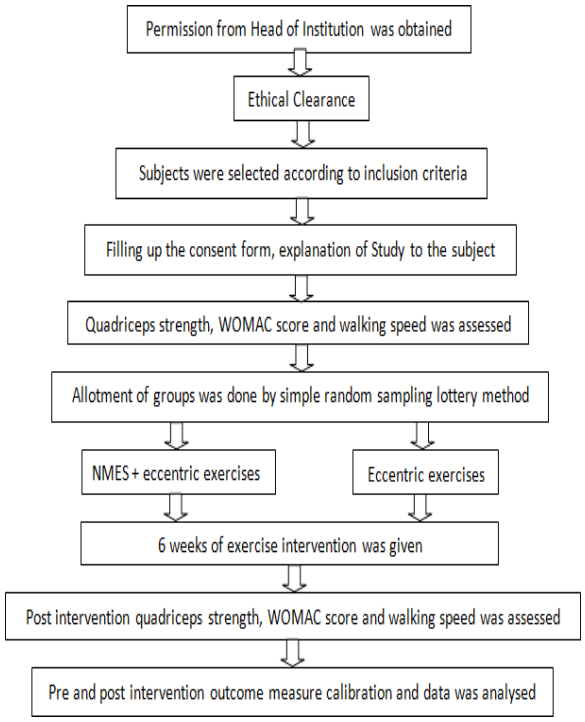
Both the groups were given the following combination of Exercise as a standard protocol of rehabilitation of type II OA.

1. Static Quadriceps: 7 REPS with 7 seconds hold
2. Hamstring Self stretches: 7 REPS with 7 seconds hold
3. Static Hip Adductors: 7 REPS WITH 7 seconds hold.



Subject made to walk on a 10 feet walkway for calculating the walking speed.

Flow chart of General Procedure:



I) Data Management and analysis procedure:

The application of STATA software version 10.1 year 2011 was utilized.

II) Plan for statistical analysis:

- STATISTICAL TESTS : PAIRED t test, UNPAIRED t test, Chi square test
- Level of significance : $p < 0.05$

RESULTS

Group 1 (NMES +ECC) expressed better increase in Maximum Voluntary Contraction of Quadriceps as compared to Group 2 (ECC). There was an increase in walking speed in Group 1 (NMES+ ECC) compared to the Walking speed in Group 2 (ECC). The WOMAC score decreased equally in both the groups.

DISCUSSION

NMES was found to improve quadriceps activation failure or strength post reconstruction.[16] The ability of NMES to improve quadriceps muscle function may be the result of an ability to generate powerful muscle actions due to the advantage of the isokinetic strengthening device and reduction in post-operative pain. In this study when it was compared to healthy individuals, patients that were exposed to eccentric exercise were capable of restoring heathy levels of quadriceps activation and strength ,whereas deficits in these measures still persisted for individuals not exposed to eccentric exercise.[28]

In a study done by Kris Jensen and Richard p di Fabio in 1989, they have analyzed the effects of quadriceps femoris muscle eccentric training program on strength gain in patients with osteoarthritis, in which the effect of 8 week eccentric exercise program on quadriceps work as evaluated in 4 groups. All 4 groups participated in home muscle stretching exercises program. As pain ratings in the work groups increased, the work ratios decreased. They concluded that eccentric exercises may be effective for treating osteoarthritis but knee pain may limit optimal gains in strength. Present study falls in similar principles and protocols according to Kris Jensen and Richard p di Fabio.

Not the less, in a recent review of evidence based strategy, La Stayo et al has stated in a study titled “The positive effects of negative work: increased muscle strength and reduced fall risk in frail elderly population in the journal of Gerontology stated that the use of eccentric exercises in the elderly population increases joint control and also reduces the risk of falls which is amongst the biggest source of injury in the elderly population.[7]

Neuromuscular electrical stimulation (NMES) is a clinical modality that has the potential to treat muscle activation failure by initiating action potentials in intramuscular nerve branches, resulting in an involuntary contraction of the muscle[13]. As NMES exogenously stimulates the muscle, large diameter Type II muscle fibers are thought to be selectively recruited, resulting in a greater potential for muscle force production. The technique of application of NMES can also be used as a form of Physical Therapy in the treatment of patients with knee OA. The methods and findings of previous studies on the effectiveness of NMES in knee OA differ on the modulation of NMES parameters, choice of outcomes used to evaluate the patients, and characteristics of the control groups. This leads to lack of consensus regarding the effectiveness attained from including NMES in conventional rehabilitation protocols. Major flaws with regard to methodological quality were found in clinical trials testing the use of NMES in conservative treatment of patients with knee OA.[15]

In my study, the use of the neuromuscular electrical stimulation has been used in a combined dosage with eccentric exercises. There is quite an amount of significance noted in this combination dosage in which parameters like maximum voluntary contraction (MVC) and walking speed has significantly increased in comparison to the control group which had a standard eccentric exercise protocol.

In this dissertation, there were a total of 60 participants each which were assigned in two groups. A total of 30 participants each were assigned to each group. In both the groups there were 12 males and 18 females. The minimum age of the participants was 45 years. 61years was the maximum age of the study population. In group 1: The age group ≤45 had minimum 4 number of participants and maximum number of participants were 11observed in the age group of 51 to 55 years. In group 2: No participants were in the age group of ≤45. Minimum numbers of participants were 6 in the age of 51 to 55 years, and maximum number of participants were 13 in ≤ 56 years. Mean age for group 1 was 52.43 ±5.32 years. Mean age for Group 2 was 53.43±5.32 years. In this study, when we analyze the graph no 2, it is seen that there is no significance of the Age distribution between the two groups as we get a P value of 0.557. In a study done by Aline Mizusaki Imoto et. al which had a similar background of study regarding the combination of NMES and Eccentric exercises in Osteoarthritis where the age distribution between the similar groups were not significant in their study. Also as discussed earlier, the mean age in years by groups had a P value of 0.66 which makes it non-significant in this study (Graph 3). As seen in graph 4, each group had a distribution of 12 Males and 18 Females each in the study. The gender distribution of the subjects in the two groups was not significant in this study as it had a P value of 1. This study falls on similar lines with the study done by Aline Mizusaki Imoto et.al which too states that the gender distribution in the two groups did not have any significance.

Talking about the Pre- Post comparison of the mean MVC within the group, there was significance seen with a P value of 0.0001 as group 1(NMES+ECC) performed better than group 2 (ECC) in terms of Maximum Voluntary Contraction. Also in this study, the mean difference of Pre-Post MVC between the groups did hot have any significance as it had a P value of 0.2806 which terms it as non significant. Similar observations were noticed in a study by Lindsey K Lepley et.all in which the combination of NMES and Eccentric exercises performed better than the dosage of eccentric exercises alone increasing the Maximum Voluntary Contraction.[9]

In case of the WOMAC scores, there was a significant decrease in both the groups. It goes in accordance to the study titled effects of combination of NMES and eccentric exercises versus an exercise program on

pain and function in patients with Knee Osteoarthritis.

Walking speed for covering a distance increased significantly in both the groups but the increase was significant in Group 1 when compared to Group 2.The values for mean difference were 0.48 ± 0.3 SD for Group 1 and 0.27 ± 0.26 for group 2. These values show that with the combination of NMES with Eccentric exercises there was a significant improvement in the walking speed compared to the dosages given by eccentric exercises alone. The findings of this study show similar results with the studies done by Lindsey K Lepley and Edward M Mojtys which also shows a significant increase in walking speed with the combination of NMES and Eccentric exercises in improving quadriceps function.[9]

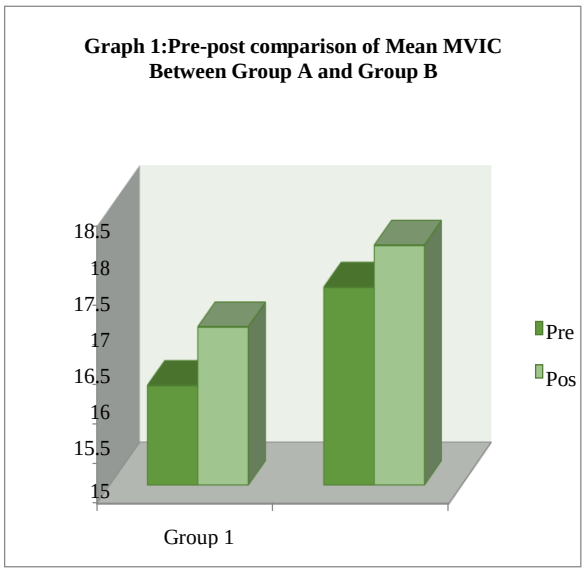
Hence Hypothesis of this study is accepted that the Combination of Eccentric exercises with Neuromuscular electrical stimulation increases quadriceps function in grade 2 knee osteoarthritis patients.

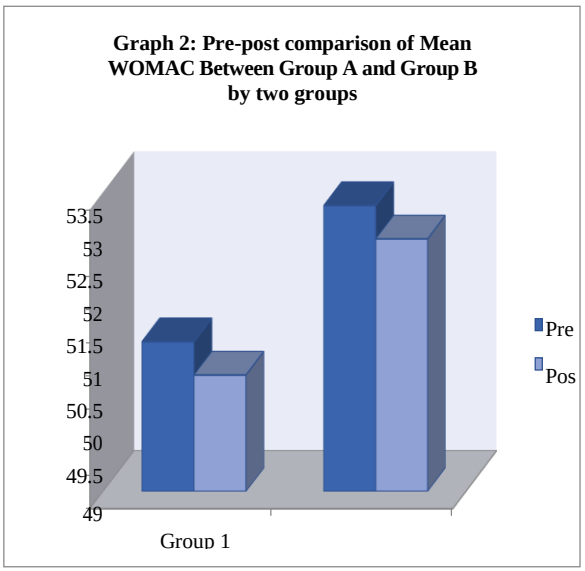
Table 1: Mean age (years) by groups

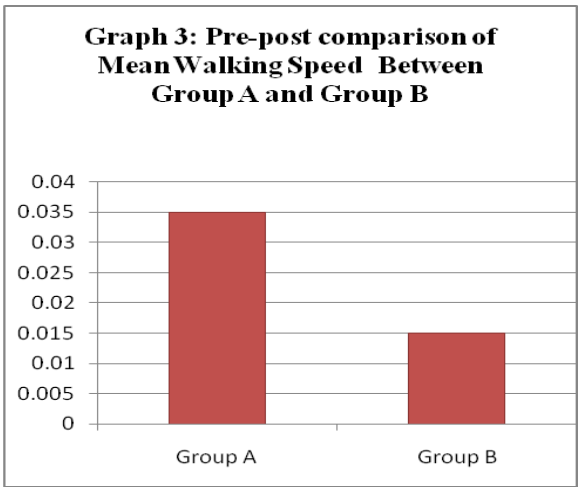
	No.	Mean & SD
Group 1	30	52.83 ±5.35
Group 2	30	53.43±5.32

Table 2: Sex distribution of subject by two groups

Age in yrs	Group 1		Group 2	
	No.	%	No.	%
Male	12	40	12	40
Female	18	60	18	60







CONCLUSION

A randomized control trial was carried out to study the effectiveness of combination of Eccentric exercise with NMES in improving Quadriceps function in Grade 2 OA Knee patients. The results concluded that Maximum Voluntary Isometric Contraction for quadriceps muscles showed improvement in both the groups after intervention. But the increase in strength was more significant in group 1 when it was compared to group 2 post intervention. WOMAC score decreased significantly in both groups. Walking speed for covering a distance increased

significantly in both the groups but the increase was significant in Group 1 when compared to Group 2.

This study concludes that the combination of Eccentric exercise with NMES improves Quadriceps function in Grade 2 OA knee patients.

LIMITATIONS:

- Study carried out at a single Physiotherapy OPD unit of a Tertiary care Hospital.

FURTHER SCOPE OF STUDY:

- Study could be further carried out at Physiotherapy OPD units of various Tertiary care hospitals.

The combination of Eccentric exercise with NMES could be carried out on Grade 3 and above classified (K&L) patients.

CLINICAL IMPLICATIONS:

Combining Eccentric exercise with NMES would significantly augment in the treatment of OA. As the quadriceps group musculature is amongst the prime muscles for mobility at the Knee joint, increasing the functioning of the quadriceps musculature would overall increase the functioning of the Knee joint.

ABBREVIATIONS

COPCARD – Community – Oriented program for control of Rheumatic diseases
CRD – Centre for Rheumatic Diseases
WOMAC – Western Ontario & McMaster Universities Osteoarthritis Index
K & L – Kellgren and Lawrence classification
SSF - Short Surged Faradic current

ACKNOWLEDGEMENTS

I sincerely thank my guide, My Colleague Dr. Pradeep Borkar and all our elderly study Participants for being active participants of the study programme, statisticians and the authorities.

Conflicts of interest: None

REFERENCES

1. Palmieri-Smith RM, Thomas AC, Wojtys EM. Maximizing quadriceps strength after ACL reconstruction. Clin Sports Med. 2008;27(3):405–24.
2. Sharma MK, Swami HM, Bhatia V, et al. : An epidemiological study of correlates osteoarthritis in geriatric population of UT Chandigarh. Indian J Community Med, 2007, 32: 77–78
3. Slemenda C, Brandt KD, Heilman DK, et al. : Quadriceps weakness and osteoarthritis of the knee. Ann Intern Med, 1997, 127: 97–104
4. Hassan BS, Mockett S, Doherty M.: Static postural sway, proprioception, and maximal voluntary quadriceps contraction in patients with knee osteoarthritis and normal control subjects. Ann Rheum Dis, 2001, 60: 612–618
5. Amin S, Baker K, Niu J, et al. : Quadriceps strength and the risk of cartilage loss and symptom progression in knee osteoarthritis. Arthritis Rheum, 2009, 60: 189– 198
6. Wigerstad-Lossing I, Grimby G, Jonsson T, Morelli B, Perterson L, Renstrom P. Effects of electrical muscle stimulation combined with voluntary contractions after knee ligament surgery. Med Sci Sports Exerc. 1988;20:93–8.
7. LaStayo PC[1], Woolf JM, Lewek MD, Snyder-Mackler L, Reich T, Lindstedt SL.) Eccentric muscle contractions: their contribution to injury, prevention, rehabilitation, and sport. Journ of Orthop Sports Phys Therapy. 2003 Oct;33(10):557-71.
8. Jamilson S. Brasileiro; Olga M. S. F. Pinto; Mariana A. Ávila; Tania F. Salvini. Functional and morphological changes in the quadriceps muscle induced by eccentric training after ACL reconstruction
9. Payal Rangarej, Dr. Pradeep Borkar, Reliability of goniometry records application for measuring range of Motion of knee joint in normal healthy individual, International Journal of Advance Research(IJAR)2020, Int. J. Adv. Res. 8(01), 978-982
10. Srushti Ramesh Gujare, Dr. Pradeep Borkar Effectiveness of mindfulness based cognitive therapy verses conventional Physiotherapy on kinesiophobia in patients with osteoarthritis of knee: a comparative study, International Journal of Advance Research(IJAR)2020, Int. J. Adv. Res. 8(01), 897-902
11. Synder-Mackler L, Lewek MD, Grimby G, Reich T, Renstorm P. Eccentric muscle contractions: their contribution to injury, prevention, rehabilitation, and sport. J OrthopSportsphysiotherapy2003 Oct;33(10):557-71.

12. M .DENA Gardiner The Principles of Exercise Therapy. 4th edition, 2005 Carolyn Kisner, Lynn Allen Colby. Therapeutic Exercise, 5th edition, 2007
13. Kim KM, Croy T, Hertel J, Saliba S. Effects of neuromuscular electrical stimulation after anterior cruciate ligament reconstruction on quadriceps strength, function, and patient-oriented outcomes: a systematic review. J Orthop Sports Phys Ther. Jul 2010
14. LaStayo PC, Woolf JM, Lewek MD, Snyder-Mackler L, Reich T, Lindstedt SL. Eccentric muscle contractions: their contribution to injury, prevention, rehabilitation, and sport. The Journal of orthopaedic and sports physical therapy. 2003;33(10):557
15. Hockberg, MC et al. Guidelines for the medical management of osteoarthritis. Part 2. Osteoarthritis of the knee. American college of Rheumatology. Arthritis Rheum. 1995;38 (11) : 1541-1546
16. Felson, DT, et al, Osteoarthritis :new insights, N Engl J Med. 2006 Jun 8, 354(23) :2520
17. Sharma et al, Physical function over 3 years in Knee OA, Arthritis Database 48:(12): 3359-5310.
18. Aagaard, Per, "The use of eccentric strength training to enhance maximal muscle strength explosive force and muscular power-consequences for athletic" The open sports sciences journal,2010, vol 3,pg 52-55
19. Bubbico, Aaron, Kravitz, len , Ph (2010),Ideas fitness Journal, 7:10
20. La Stayo, Paul C; Ewy, Gordon A; Perotti, David D; Lindstedt; Stan, May(2003) " The positive effect of negative work; Increased muscle strength and reduced fall risk in frail elderly population" Journal of Gerontology. 58 A(5);419-424
21. Howlett K, T Keniston, A Grassl, A Oslon; Jan 2011 "An initial assessment of eccentric exercise using the quadmill, Dept of exercise science, Gonjaga University, Spokane, WA
22. Hernandez HJ, Mcintosh V, Leland A, Harnis love mo(2015). Progressive resistance exercise with eccentric loading for management of knee OA. Frond. Med.2:45 doi:co 3384/fmed 2015.0004J
23. Gaines JM et. al ;The effect of NMES stimulation on arthritis knee pan with osteoarthritis of knee; Appl Nurs Res. 2004
24. Giggins O, et al; NMES in treatment of knee OA, a systematic review and meta analysis;Clin Rehab 2012 oct;26
25. Aline Mizusaki Imoto,Kelson Nonato Gomes da Silva et.al ; " Effects of neuromuscular Electrical combined with Exercise versus an Exercise program on the pain and the function I patients with knee Osteoarthritis : A randomized controlled trial"; Boimed research international volume 2013, Article ID 202018
26. D T Felson," Developments in the clinical understanding of Osteoarthritis," Arthritis research and therapy , vol II ,No I , article 203,2009
27. T S Fidelix, B G Soares and V F Trevisani,"Diacerin for Osteoarthritis," Cochrane database of systemic reviews, Article ID CD 005117, 2006
28. D A Reid and PJ McNair, "Effects of acute quadriceps stretch in people with or without osteoarthritis of knee"; Physiotherapy, vol 96,no 1,2010

How to cite this article: Mathew S, Janbandhu K, Borkar P. Effectiveness of eccentric exercise and neuromuscular electrical stimulation on quadriceps function in grade II osteoarthritis- a randomized control trial. International Journal of Research and Review. 2020; 7(4): 328-335.

******