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Original Research Article

COMPARISON OF THE EFFECT OF DELORME AND MACQUEEN STRENGTHENING PROTOCOL FOR IMPROVING QUADRICEPS MUSCLE STRENGTH IN NORMAL FEMALE INDIVIDUALS

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ABSTRACT

Background: Resistance exercises given at fitness centers by the training personnel usually lack individuality and specificity which causes easy fatigability and soreness in muscles. Also it is one of the important causes for discontinuation of exercise regimen. Hence to cope up with the increasing demands of individuals with respect to physical fitness and well-being, there is a need for development of a uniform yet tailor made effective strengthening protocol for conditioning purposes without producing muscle soreness. Hence the current study was performed.

Purpose of study: To compare the effectiveness of Delorme and Macqueen strengthening technique on quadriceps muscle in healthy female individuals.

Materials and Methodology: After fulfilling the inclusion criteria, a total of 34 subjects were randomly allotted in Delorme and Macqueen strengthening groups, each group consisting of 17 subjects. They were given 10 min of warm up followed by respective strengthening regimens with Delorme and Macqueen technique for quadriceps muscle. Supervised strengthening was given for 4 days a week for total duration of 4 weeks. Assessment of outcome measure that is 1RM for quadriceps muscle strength and VAS for DOMS was done at week 0 and after 4 weeks of intervention.

Result: On statistical analysis, significant improvement was seen on intra group comparison with p value of 0.00 however inter group analysis revealed that there was non-significant difference in improving quadriceps muscle strength in between two groups post 4 week of intervention. Also there was no evidence of Delayed onset of muscle soreness (DOMS) with both the resistance protocols.

Conclusion: Both the progressive resistance exercises were found to be equally effective in improving quadriceps muscle strength in healthy female individuals post 4 weeks of intervention. Clinical implication- Both strengthening techniques can be effectively implemented in fitness centers for strengthening purposes in healthy individuals especially for planning long term exercise routine.

KEY WORDS: PRE, Delorme Technique, Macqueen Technique, Quadriceps Muscle, Females.

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INTRODUCTION

Resistance training is a form of physical activity that is designed to improve muscular fitness by exercising a muscle or a muscle group against external resistance resulting in positive health outcomes [1]. It forms an essential element of rehabilitation program for individuals with impaired function helping in maintenance of health and physical well-being in individuals, reducing the risk of injury [2]. It is a form of active exercise in which static or dynamic contraction of the muscle is resisted by an external force applied either manually or mechanically. In mechanical resistance exercise, load is applied by exercise equipment. Frequently used regimens in conditioning programs for resistance training are Progressive resistance exercise (PRE), Circuit weight training, Plyometric training, Isokinetic training regimens etc. [2]. These exercise systems work on overload principle and they improve muscle strength, power and endurance which form important health and skill related physical fitness components in individuals and athletes respectively [1,2].

The concept of Progressive resistance exercise (PRE) was introduced by Thomas L. Delorme about 60 years ago [3]. It is a dynamic resistance training method where external load is applied to the contracting muscle by mechanical means and load is incrementally or progressively increased as the muscle strength improves [4]. PRE includes three strengthening techniques- Delorme and Watkins technique, Macqueen technique and Oxford technique. The basis for determining and progressing resistance in PRE is the Repetition maximum (RM). Repetition maximum is the greatest amount of weight (load) a muscle can move through the available ROM a specific number of times [2]. Usually One repetition maximum (1RM) is tested which implies to the heaviest load that can be moved in full available ROM against gravity only one time with correct performance [5]. Similarly when maximum load can be lifted 10 times in full range of motion against gravity with correct performance is 10RM. These testing parameters are usually included in athletes for improving muscle strength and endurance however very rarely tested in normal healthy individuals.

Research has demonstrated that maximal and submaximal strength tests are very rarely used for exercise prescription in gyms and physical fitness centers [5]. There is a lack of operational strengthening regimens at various physiotherapy set ups as well, which can enhance the muscle strength. Resistance exercises given by the training personnel usually lack specificity, resulting in muscle taxing causing easy fatigability and muscle soreness which is one of the most important cause of discontinuation of exercise regimen. Hence more exploration is required in the field of resistance training to cope up with the increased demands imposed on the individual in today's lifestyle especially with respect to physical fitness and well-being. Due to this increased awareness in individuals about their health status, there arises a need for development of a uniform yet tailor made effective strengthening protocol for conditioning purposes.

Previous researchers have studied the effectiveness Delorme and Oxford technique on muscle strengthening however Macqueen technique has not been studied on earlier for research purpose [6]. There is a dearth of literature with respect to this Progressive Resistance exercise technique. Hence the present study aimed at evaluating the effectiveness of Delorme and Macqueen strengthening technique for quadriceps muscle. In Delorme and Watkins PRE technique, a warm up period built up in the protocol by giving load progression at each set of repetition whereas in Macqueen Technique constant load is applied throughout the protocol without a warm up set [2]. HURR leg extension device was used for training quadriceps muscle in current study. It is a well designed and manufactured pneumatic device which provides a convenient measurement setup for assessing gross muscle characteristics [7].

Therefore this study aims at evaluating the effectiveness of Delorme and Macqueen strengthening technique on improving quadriceps muscle strength in healthy female individuals over a period of 4 weeks and to find which of the two techniques results in delayed onset of muscle soreness post training sessions.

MATERIALS AND METHODS

This Randomized control trial was conducted in

Outpatient department set up of tertiary care centers. The study duration was 4 months and it was approved by the institutional ethical committee. A total of 35 healthy females within the age group of 20-25 (22.22+/-1.34) years with grade 5 quadriceps muscle strength were included in the study after screening them with PAR-Q and YOU questionnaire. A written informed consent was taken from all the subjects before participation in the study. Females with knee pathology/surgery; recent history of fall on the knee; doing a gym program with any dietary restrictions/considerations were excluded from the study. A written informed consent including detailed explanation about the purpose and procedure of the study was taken from all the subjects before beginning the intervention. Demographic data was obtained from all the subjects prior.

Materials used for this study: Hurr leg extension machine, Digital weighing scale, Calculator, Max load calculator, Microsoft excel sheet.

Patient Allocation: Patients included in the study were divided into two groups - Group A and Group B by simple random sampling. Out of 34 subjects, 17 subjects were allotted group A that is Delorme Technique and 17 were allotted group B that is Macqueen Technique.

For all the subjects included in the study, 20-25% of body weight was calculated after recording their body weight [2]. The calculated weight(load) was correlated to the gauge unit(for pneumatic pressure hurr device) and the value was set accordingly on HURR knee extension equipment. The subjects were asked to sit on leg extension device in 90 degrees of hip and knee flexion with a back support. Demonstration of the technique was given prior. Subjects were told to perform as many repetitions as possible for quadriceps muscle by performing knee extension (dynamic quadriceps) in full ROM for right lower extremity till fatigue [2]. Load and repetitions performed by the subject were noted and 1RM was calculated using the max load calculator [8,9]. To minimize possible testing errors; (a) all subjects were given standard instructions on exercise technique, (b) exercise technique was monitored and corrected whenever needed, and (c) all subjects received verbal cues and encouragement. Then 10 RM was calculated as 75% of 1RM[2]. Similarly ½ and 3/4th of 10RM was calculated for Delorme technique and documented. Subjects were explained and were shown the technique of performing the strengthening program for quadriceps muscle on knee extension HURR equipment.

The strengthening protocols given to the patients were as follows.

Delorme technique	MACQUEEN TECHNIQUE
10 lifts with ½ of 10 RM	10 lifts with 10 RM
10 lifts with 3/4 th of 10 RM	10 lifts with 10 RM
10 lifts with 10 RM	10 lifts with 10 RM
30 lifts 4 times weekly.	40 lifts 3 times weekly

For both the techniques, progression was done every 2 weekly [10].

Subjects in both the groups were given 10 min of warm up session every day prior to the session. Warm up session included walking, free exercises for upper and lower limb. Subjects were then demonstrated (on 1st day) with the technique of performing knee extension on hurr device as per their respective protocols.

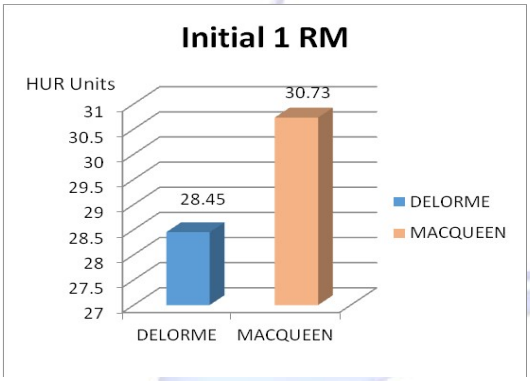
After every set of 10 repetitions in both techniques, 2 minutes of rest interval was given to all the subjects [11]. Post strengthening session, cool down exercises in the form of stretching for lower extremity muscles was given to all subjects. Each individual was asked to report muscle soreness every day, if experienced, after 24 hours and it was noted on VAS[2]. After two weeks new 1RM was calculated for all the subjects according to the method explained above and progression was made with the subjects performing strengthening program with new readings. This protocol continued under supervision for 4 weeks with 30 min session performed 3-4 days a week [1]. After four weeks final 1RM of the individual was calculated again. The results were then obtained and analyzed further.

Outcome measures used were 1RM [5,12] for assessing quadriceps muscle strength and Visual analogue scale (VAS) for Delayed Onset of Muscle Soreness [13]. Assessment of 1RM was done prior at week 0 and at week 4 after intervention. For assessment of DOMS, subjects were instructed to report about muscle soreness, on VAS, 24 hours post every training session till 4 weeks.

Statistical analysis was done using paired and unpaired t test for the parametric measures. Paired t test was used for within group comparison and unpaired t test was used for comparison between the two groups- Delorme and Macqueen group.

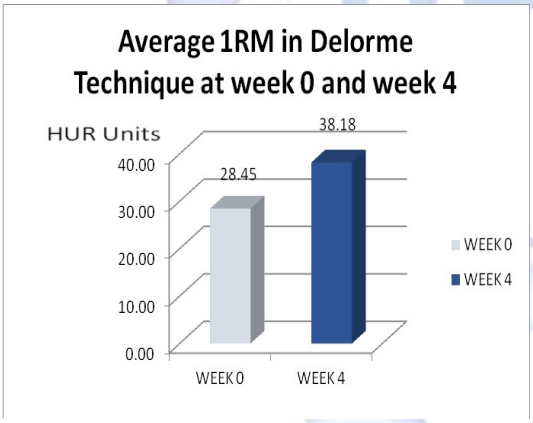
The level of significance was p value $\leq$ 0.05.

Graph 1: Comparison of 1RM values between Delorme and Macqueen strengthening techniques at week 0.



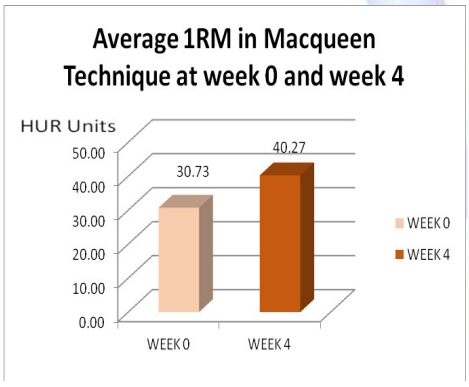
The p value is 0.44 which is not significant for 1RM at week 0 indicating baseline matching.

Graph 2: Comparison of average 1 RM in Delorme Technique at week 0 and week 4.



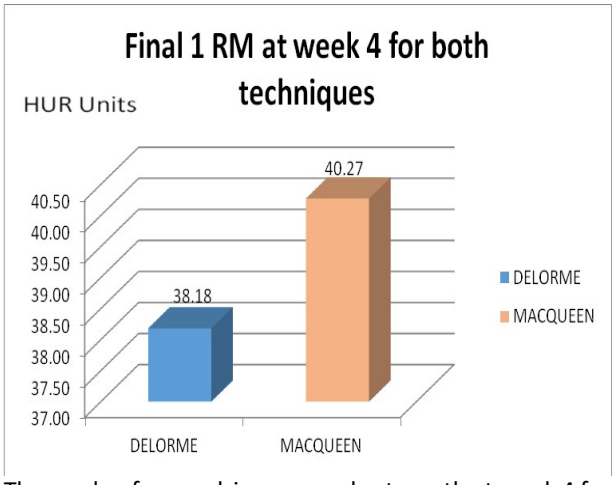
The p value for strength in quadriceps muscle with Delorme technique at week 0 and week 4 is 0.0003 which is significant.

Graph 3: Comparison of average 1 RM in Macqueen Technique at week 0 and week 4.



The p value for quadriceps muscle strength with Macqueen technique at week 0 and week 4 is 0.0093 which is significant.

Graph 4: Comparison of 1RM values between Delorme and Macqueen strengthening techniques at week 4.



The p value for quadriceps muscle strength at week 4 for both the techniques is 0.46 which is not significant.

DISCUSSION

This experimental study design was performed to compare the effectiveness of two strengthening protocols- Delorme and Macqueen techniques on quadriceps muscle in healthy female individuals. Also one of the objectives of the study was to find out which of the two technique produces delayed onset of muscle soreness after 24 hours of exercise intervention. A total of 35 subjects were included in the study, of which, 30 completed the study. The five drop outs from the study were due to non-compliance with the intervention of performance of exercises for minimum of 3 days a week. The demographic data for age and BMI was matched. Also baseline matching for 1RM was done for both the techniques with p value of 0.44 which is non-significant.

The statistical analysis of the study revealed that onintra group comparison of 1RM for Delorme technique and Macqueen technique, there was a significant improvement in quadriceps muscle strength in subjects of both the groups indicating that both the progressive resistance strengthening protocols were effective to bring about improvement in quadriceps muscle strength after 4 weeks of intervention. On inter group analysis, the p value was found to be non-significant between two groups indicating that both Delorme and Macqueen techniques were equally effective in quadriceps muscle strengthening post 4 weeks of intervention.

As per the results obtained, changes in quadriceps muscle strength on intra group analysis could be due to the neural adaptation occurring post resistance training. There was about 27% increase in quadriceps muscle strength with Delorme technique and 24% with Macqueen technique. During the initial period of resistance training program, rapid gain in the tension generating capacity of skeletal muscle is largely attributed neural responses taking place and not just the adaptive changes in muscle. Also the electromyographic activity in the muscle increases during 4-8 weeks of resistance training program with little evidence of muscle fiber hypertrophyaccording to a study [14]. Moritani and DeVriesin another study documented that in the time course of muscle strength gain, neural factors accounted for the larger proportion of the initial strength increment and thereafter both neural factors and hypertrophy were found to increase in strength with hypertrophy becoming the dominant factor after first 3 to 5 weeks [15].

The primary objective of the study was to determine an effective method for improving muscle strength amongst Delorme and Macqueen strengthening techniques. According to results obtained after statistical analysis, both the protocols were found to be equally effective in improving quadriceps muscle strength in all the subjects post 4 weeks of intervention. This suggests that there is no significant difference with respect to strength benefits on quadriceps muscle after 4 weeks in subjects when compared between both the groups. De Silva et al found similar results as the present study where they compared Delorme and Oxford resistance training techniques on lower limb strength by calculating their 10RM. They observed that there was similar muscle performance post 4 weeks of intervention proving both techniques having significant but comparable muscle strength gains [16]. In another randomized clinical trial done by fish de et.al showed that subjects in both Delorme and Oxford protocol were able to complete their lifting assignments over a period of 9 weeks and it was concluded that both resistance training protocols brought about improvement in muscle strength with equivalent efficacy which supported findings of present study [6]. In addition, similar acute neuromuscular adaptations occur with Delorme and Oxford resistance training protocols as was documented in a study by Pereira et al where Electromyographic activity of upper limb muscles was recorded post 4 weeks of resistance training program which showed to have similar strength gains similar to current study results [17].

One of an important observation found in the study was than most of the subjects involved, complained of pain on the medial aspect of the knee while performing the strengthening techniques. This could be attributed to the fact that median frequency of vastuslateralis is higher than median frequency of vastusmedialis during voluntary muscle contraction as observed in the study by Pincivero et al where EMG activity of these two muscles was recorded during knee extension [18]. Thus weakness in vastusme-dialis muscle could be the cause of medial aspect knee pain while performing the resistance training program however the subjects could complete the required set of repetitions set for both the technique.

Secondary objective of the study was to find out whether any of the two techniques produced Delayed-onset muscular soreness (DOMS) in the subjects. DOMS is the sensation of pain and stiffness in the muscles that occurs from first to fifth day following unaccustomed exercise which can adversely affect muscular performance [19]. It is one of the important cause for non-compliance to exercise regimens especially at gyms and other health care centers where improper exercise intensity, excessive load or lack of warm up and cool down sessions cause muscle soreness and pain. However it was observed that both the techniques did not produce DOMS. The protocols have been designed in an appropriate manner such that despite of the difference in application of the techniques, Delorme being progressive incremental load technique where three sets are performed in gradual progression done as 50% and 75% of 10 RM followed by 10 RM and Macqueen being fixed load technique where four sets are performed with 10 RM directly, both can be given to individuals without occurrence of DOMS which can be better tolerated by the individuals

along with required strength benefits.

Thus as per the results obtained from our study, both the protocols will cause individual specific significant strength gains without producing muscle soreness thus they can be better tolerated by subjects resulting in increased exercise compliance causing important health benefits.

The limitation of the study was the small sample size; dietary consideration was not done for the subjects; only female subjects were included in the study.

Clinical Implication: Both Delorme or Macqueen resistance strengthening techniques can be effectively implemented in fitness centers for strengthening purposes in healthy individuals especially for planning long term exercise routine.

CONCLUSION

Both the resistance training protocols Delorme and Macqueen techniques were equally effective in improving quadriceps muscle strength over a period of 4 weeks of intervention in healthy female individuals.

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Conflicts of interest: None

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