*IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)*
*e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 16, Issue 6 Ver. V (June. 2017), PP 66-74*
*www.iosrjournals.org*

# Comparative Effectiveness of Isometric, Isotonic, Isokinetic Exercises on Strength And Functional Performance of Quadriceps Muscle in Normal Subject

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***Abstract***
***Introduction:*** *Strength is defined as maximum voluntary force exerted in a single muscular effort. Isometric, isotonic, isokinetic all produce significant and substantial gains in muscle strength. Further, no single system or product has been found to be superior to any other when the studies have been well-controlled. Aim of the study is to get a better understanding of 3 types of strength testing and training of quadriceps in normal subjects and to compare the effectiveness of isometric, isokinetic, isotonic strength of quadriceps in normal subjects.*
***Materials And Methods:*** *A total of 30 normal subjects were recruited randomly from physiotherapy department of SVNIRTAR according to the inclusion and exclusion criteria. Subjects were randomly assigned into 3 groups; 10 subjects were taken into each group; isometric, isotonic and isokinetic training groups which received isometric, isotonic and isokinetic strength training of quadriceps muscle of left side respectively for 4 weeks. All participants were undergone pre and post test assessments of all types of strengths of left quadriceps ie isometric, isotonic and isokinetic with isokinetic device and functional performance testing for left lower limb by triple hop distance test (THDT). The study design was a three group, pre-test post-test structured, experimental study design.*
***Results:*** *The overall result of the study showed that in all the 3 interventions (isotonic training, isokinetic training and isometric training), quadriceps strength was improved significantly with time. When isokinetically tested, most improvement was seen in isokinetic training group. And among isotonic and isometric training group, isotonic training group showed significantly more improvement. Also only isotonic training group showed significant improvement in functional performance with time from pre to post readings after 4 weeks of training.*
***Conclusion:*** *Isokinetic testing can establish the significant improvement in strength gains in all three training groups whereas isometric and isotonic testing can show improvement in their own type. Thus, isokinetic testing is the best way of strength testing. Among all three training modes, Isokinetic strength training can improve the strength maximally, so it is the best way of training as well. Isotonic strength training is the best way of increasing functional performance (THDT).*
***Keywords:*** *Isometric, Isotonic and Isokinetic strength training, quadriceps muscle isokinetic dynamometer, triple hop distance test.*

## I. Introduction

Strength is defined as maximum voluntary force exerted in a single muscular effort. It is a fundamental quality in achieving optimal physical function and is defined as the ability to produce more force. [1] Isometric, isotonic, isokinetic all produce significant and substantial gains in muscle strength. Further, no single system or product has been found to be superior to any other when the studies have been well-controlled.Studies suggest that disadvantages of isometric strengthening is that limited overflow and muscle coordination is not integrated and strength is only measured at one position in the ROM. [2] If through the complete ROM, strength is to be studied, then various isometric contractions have to be performed at various joint positions. [3] Studies also suggested that in isokinetic strengthening, the effort can be minimal, maximal or anywhere in between because it only controls the speed of movement. Isotonic and isokinetic contractions present different biomechanical characteristics. In the isotonic mode, the neuromuscular system has to overcome an initial resistance (constant throughout the movement) to move the lever arm. Consequently, isotonic contraction is supposed to maximally load the neuromuscular system only at the weakest mechanical points of the range of motion, whereas the rest is worked at less than maximal capacity. By contrast, the isokinetic mode implies an accommodating resistance, which allows a constant angular velocity once the preset velocity is reached. Therefore, the isokinetic movement is expected to maximally load the neuromuscular system through the overall range of motion. Isokinetic exercises allow for the development of max resistance throughout the full ROM. Also these exercises can be performed at a variety of speed with max resistance. This is more imp as power can only be maximised with

high speed training. [4-6] Studies suggested that accuracy of isokinetic testing showed that the reliability and validity of various isokinetic devices are acceptable. [7-10]
There still exist controversies regarding the effectiveness of mode of testing and training quadriceps strength.

**Aims and Objective of the study**
To get a better understanding of 3 types of strength testing and training of quadriceps in normal subject and to compare the effectiveness of isometric, isokinetic, isotonic strength of quadriceps in normal subjects.

## II. Methodology

**Study design:** .The study was done on students of Physiotherapy Department of SVNIRTAR, Olatpur, Cuttack. A total of 30 subjects were recruited from physiotherapy department of SVNIRTAR according to the inclusion and exclusion criteria. The sampling method was random sampling method with the help of which a sample of 30 subjects was selected randomly. And were randomly assigned into 3 groups; 10 subjects were taken in each group. The study design was a three group, pre-test post-test structured, experimental study design.

**Inclusion criteria:** Normal healthy subjects were selected in the study, Age of subjects was in between 18-30 years and both the genders were included in the study.

**Exclusion criteria:** Subjects who had history or evidence of lower extremity, musculoskeletal or neurological problems, cardiovascular, respiratory or major systemic- disorder, insufficient strength to complete base line testing or participation in any type of vigorous or recreational activity, aerobic or weight training program during 6 months prior to the study.

**Procedure:** Subjects who had fulfilled the inclusion and exclusion criteria were recruited & randomly assigned into 3 groups- isometric isotonic and isokinetic training which received isometric, isotonic and isokinetic strength training of quadriceps muscle of left side respectively for 4 weeksWritten informed consent was taken from each subject before participation**.** All participants were undergone an initial baseline assessment of all types of strength of quadriceps i.e. isometric, isotonic and isokinetic; with isokinetic device for left lower extremity and functional testing for left lower limb by triple hop distance test (THDT).

**Isokinetic strength testing-**

In isokinetic dynamometry torque was measured during a concentric muscle contraction (i.e. the muscle shortens), while the angular velocity of the limb segment was held constant throughout the range of motion (r. o .m.). The constant angular velocity was provided by the dynamometer.
Subjects were instructed to extend the knee as far as possible and then to flex as far as the device allows. And they were instructed to move as hard and fast as possible throughout the entire ROM.
The participants completed 3–5 maximal repetitions at 60°·s –1. After a 30–60 s rest, the participant completed 3–5 maximal repetitions at 180°·s –1. After another 30–60 s rest, the participant completed 3–5 maximal repetitions at 300°·s –1.
The peak torque (N·m), the highest of the 3–5 trials, for knee extension was recorded.

**Isometric strength testing-**

After complete preparation, subjects were asked to perform max isometric contractions of knee at 20, 40, 60, 90 degrees of knee flexion angle against resistance. Subjects were directed to build up to his max strength as rapidly as possible without jerking and to hold it until told to relax. Hold time was of 3-5 secs and rest periods of 10 secs were taken between consecutive isometric contractions of quadriceps. The peak torque (N·m), the highest of the 3–5 trials, for knee extension was recorded.

**Isotonic strength testing-**

The isotonic quadriceps strength was determined with the patient in a high sitting position with back support. The load was selected according to the subject's tolerance. The loads were attached to the ankle, and the participants were instructed to lift the load from 90 deg knee flexion to full knee extension. Subjects were instructed to push the lever arm as hard as possible in an attempt to move the weight through the entire ROM for 10 times. Each participant had lifted the weight according to muscle fatigue.

That torque i.e. 10 R.M torque was noted for that participant, to check the strength of muscle before and after the isotonic exercises. 10 number of times the participant lifted the load before getting fatigue, from 90 deg flexion to full extension, it was recorded as the equivalent to 10 repetition maximum (RM) of the load. The peak torque for 10 (RM) was recorded.

**Interventions-**

**Isometric training-**

**Multiple angle isometrics-** Each subject was asked to do general body warm up for 5 minutes i.e, easy stationary cycling followed by a 5 min rest interval.

Resistance was applied at 20,40,60,90 degrees of knee extension training angle. The contraction time was hold for 10 secs with 10 secs relaxation.

The exercise started with 2 sets with 10 repetitions in initial 2 weeks and progressed to 3 sets with 10 repetitions hold for 10 secs with 10 secs relaxation in further 2 weeks.

**Isotonic training-**

Each subject were asked to do general body warm up for 5 minutes i.e. easy stationary cycling followed by a 5 min rest interval. Concentric isotonic resisted knee extension exercise was performed. One repetition max was calculated. Then 10 RM was determined. Each exercise session consisted of 3 sets of 10 repetitions and 1 minute rest in between the sets. Each exercise session was performed 3 times a week for 4 weeks. Protocol was according to De Lorme (PRE)

10repetitions with 50% of 10 RM
10repetitions with 75% of 10 RM
10 repetitions with 100% OF 10 RM

**Isokinetic training-**

Subjects were asked to do general body warm up of 5 min ie easy stationary cycling followed by 5 min rest interval. Isokinetic knee extension concentric exercises was given at speed of 220°·s –1, 160°·s –1, 100°·s –1, 40°·s –1. Each exercise session consisted of 4 sets of 10 repetitions and 1 minute rest in between the sets.

Each exercise session was performed 3 days a week for 4 weeks.

| | | | | |
|---|---|---|---|---|
| Speed- | 220 | 160 | 100 | 40 |
| Rep- | 10 | 10 | 10 | 10 |
| Sets- | 1 | 1 | 1 | 1 |

Rests- 1 min between the sets

All participants were again undergone assessment of all types of strength of quadriceps ie isometric, isokinetic and isotonic; with isokinetic device and functional testing by triple hop distance test. Results were compared.

**Data collection**

Measurements were taken for all the dependent variables for all the subjects. After 4 weeks of strength training, post test measurements were taken for all the dependent variables in each subject.

**Data analysis**

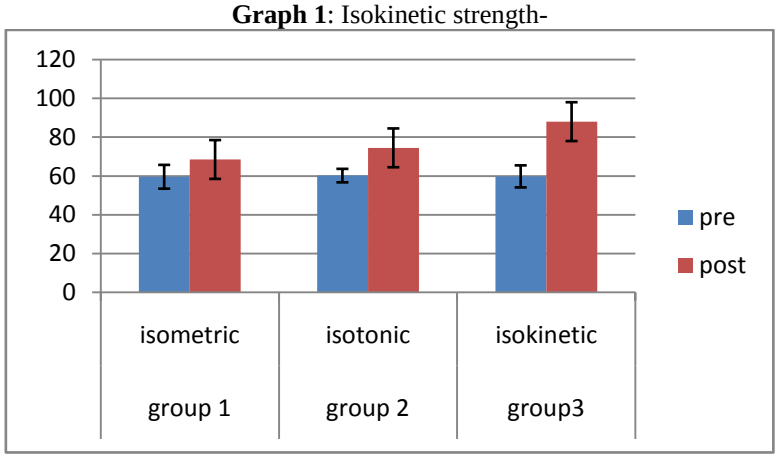
The data was analysed with SPSS (statistical package for social sciences), 16.0 version for windows. The dependent variable were analysed using a mixed design 3 int0 3 ANOVA, with repeated measurements in second factor. There was one between factor with 3 levels (isometric training group, isotonic training group, isokinetic training group) and one within factor (time- pre and post). An alpha level of 0.05 of significance was set for all tests**.**

## III. Results

**Strength-**

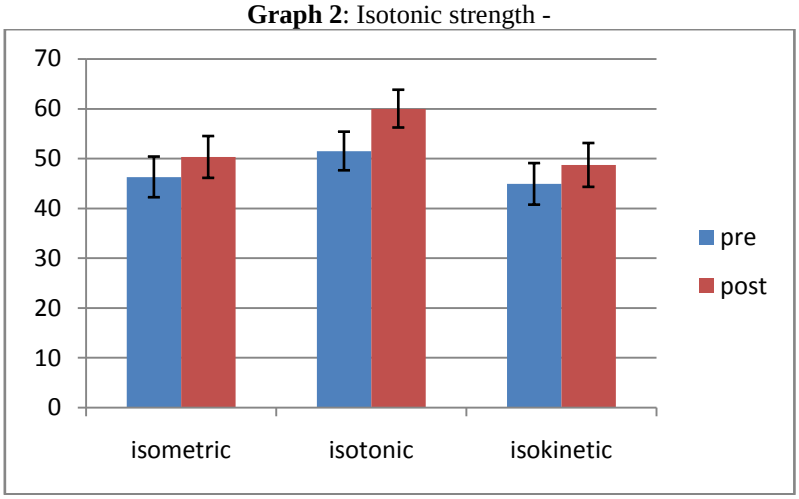
GRAPHS illustrates that there was improvement in quadriceps strength as measured by the isokinetic device from pre to post readings in all the experimental groups. (Isometric, isotonic, isokinetic training groups)

**Graph 1**: Isokinetic strength-




Graph 1 illustrates that there was improvement in quadriceps isokinetic strength as measured by isokinetic device from pre to post readings in all experimental groups. However, greatest degree of improvement of strength was noticed in isokinetic training group. There was main effect for time (F=737.063 ,df=1 ,p=0.000).There was no main effect for group (F= 0.915 , df =2 , p=0.412).There was main effect for time × group ( F= 82.978 ,df=2, p=0.000) Post Hoc analysis showed that the significant improvement was seen in all 3 groups. Most improvement was seen in isokinetic training group followed by isotonic training group.

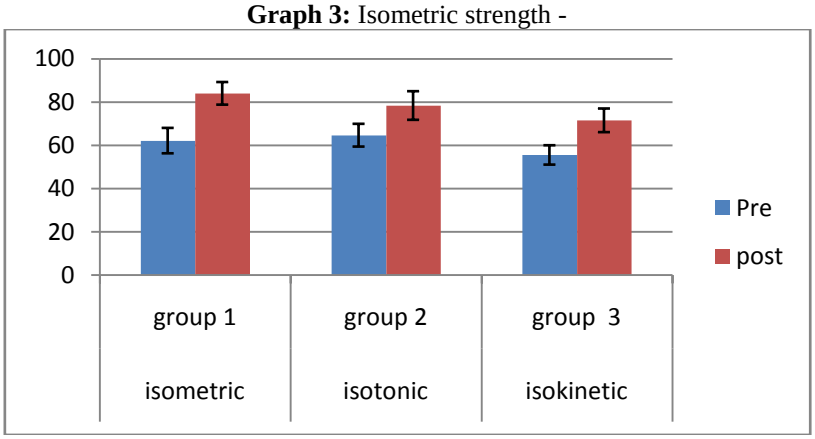
**Graph 2**: Isotonic strength -




Graph 2 illustrates that there was improvement in quadriceps isotonic strength as measured by isokinetic device from pre to post readings in all experimental groups. However, greatest degree of improvement of strength was noticed in isotonic training group.

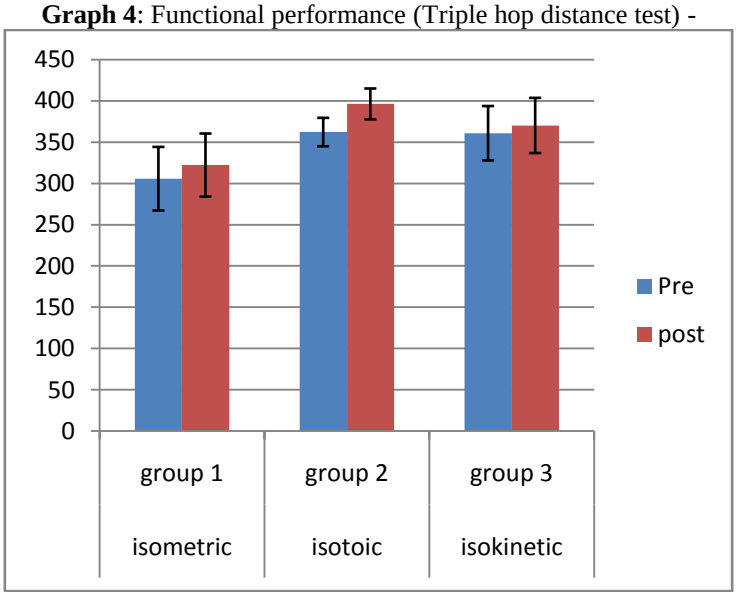
There was main effect for time (F=43.149, df =1, p=0.000).There was no main effect for group (F=1.424, df =2, p=0.258).There was no main effect for time × group (F=3.332, df= 2, p=0.051)

**Graph 3:** Isometric strength -



Graph 3 illustrates that there was improvement in quadriceps isometric strength as measured by isokinetic device from pre to post readings in all experimental groups. However, greatest degree of improvement of strength was noticed in isometric training group.
There was main effect for time (F=151.654, df =1, p=.000).There was no main effect for group (F=0.903, do=2, p=0.417).There was no main effect for time × group (F=3.005, df=2, p=0.066)

**Graph 4**: Functional performance (Triple hop distance test) -




Graph 4 illustrates that there was improvement in functional performance by triple hope distance test in all three training groups. However, greatest improvement was noticed in isotonic training group in functional performance from pre to post readings. There was main effect for time (F=32.44, df=1, p=0.000).There was no main effect for group (F=1.239, df =2, p=0.306).There was main effect for time × group (F= 4.372, df= 2, p=0.023) Post Hoc analysis showed that the significant improvement was seen in only in isotonic training group.

## IV. Discussion

In our study, the overall result of the study (comparative effectiveness of isometric, isotonic, isokinetic exercises on strength and functional performance of quadriceps muscle in normal subjects) showed that in all the 3 interventions, (isotonic training, isokinetic training and isometric training) quadriceps strength improved significantly with time. When isokinetically tested, most improvement was seen in isokinetic training group. And among isotonic and isometric training group, isotonic training group showed significantly more improvement.
Also in our study, only isotonic training group showed significant improvement in functional performance with time from pre to post readings after 4 weeks of training.

**Quadriceps strength**-

**Isometric strength**- for isometric strength, isometric training group improved more (35.18%) as compared to isokinetic training group (28.83%) and isokinetic training group improved more than isotonic training group (21.24%). There were no significant differences in between the groups.

**Isotonic strength**- for isotonic strength, isotonic training group improved more (16.5%) as compared to isometric training group (8.64%) and isometric training group improved more than isokinetic training group (8.46%). There were no significant differences in between the groups.

**Isokinetic strength**- for isokinetic strength, isokinetic training group improved more (47.16%) as compared to isotonic training group (23.75%) and isotonic training group improved more than isometric group (14.93%). There were significant differences in between the groups.
In our study, quadriceps strength was improved significantly with time from pre to post readings after 4 weeks of training.

This improvement in the quadriceps strength within 4 weeks in our study can be well attributed to the fact explained by Moritani & DeVries et al., according to which this increase in quadriceps strength which is evidenced in the first few weeks of resistance training is more associated with neural adaptations which encompass the development of more efficient neural pathways along the route to the muscle. The motor unit

(motor nerve fibre and the muscle fibres it innervates) recruitment is central to the early (2 to 8 weeks) gains in strength. [11] Also in our study, the percentage of improvement in all three types of the testing (isometric strength, isotonic strength, isokinetic strength) showed that the improvement in each was maximum with its own type of training programme from pre to post readings after 4 weeks of training. As in our study, isometric training improved isometric strength, isotonic training improved isotonic strength and isokinetic training improved isokinetic strength. So these results can be better explained by principles of learning.

Motor learning is the study of the processes involved in acquiring and refining skills. Motor learning is a change, resulting from practice or a novel experience, in the capability for responding. It often involves improving the smoothness and accuracy of movements. Thus learning the particular skills (isometric strengthening in isometric training group, isotonic strengthening in isotonic training group and isokinetic strengthening in isokinetic training group), had resulted in increase in capability of responding after practicing them.From all three groups which underwent their respective training, strength was increased in all of them but it was statistically significant (47.18%) in isokinetic group.So as our results simply implies the impact of learning principles in all 3 training groups. This can further and better explained by evidences.

One study showing Improvement in isokinetic strength after giving isokinetic strengthening; thereby supporting our result is by Akima Hetal 1999, Early phase adaptations of muscle use and strength to isokinetic training; The purpose of this study was to investigate the effect of short periods of isokinetic resistance training on muscle use and strength. Seven men trained the right quadriceps femoris muscles (QF) 9 d for 2 wk using 10 sets of 5 knee extensions each day. Isometric and isokinetic torques of QF were measured at six angular velocities. Cross-sectional areas (CSA) of QF were determined from axial images using magnetic resonance imaging (MRI. Muscle fiber types, fiber area, and phosphofructokinase (PFK) activities were determined from biopsies of the vastus lateralis muscle. No changes were found in CSA of QF, muscle fiber types, fiber area, and PFK activities after the training. Isometric and isokinetic peak torques at 60-240 degrees x s (-1) and relative area of QF activated by knee extensions increased significantly after the training. These results suggest that muscle strength increases after short periods of isokinetic resistance training without muscle hypertrophy would be due to increased muscle contractile activity. [12]

And also one study supporting the result by learning principle suggested that improvement in isometric strength after giving multiple angle isometrics was also done by, Bandy and Hante, who studied the effects of multiple angle quadriceps training**,** they trained 107 women isometrically at 30, 60 or 90 degs of knee flexion, strength measurements were taken at 15 degs increments from 15 degs - 105 degs. All groups showed significant improvement at angles other than the one exercised. The group that trained 30 degs showed the least improvement, but still had significant strength increases at 15, 30, 45, 60 deg. The group that trained at 90 degs of knee flexion showed the most improvement, demonstrating the significant strength increases at all measured angles. This simply suggests that quadriceps isometric training at multiple angles results in improvement in quadriceps muscle. [13]

Similarly, learning principle showing isotonic training improves isotonic strength can be well explained by Delorm's study suggesting that progressive resisted isotonic protocol of strength which increases strength overtime. Dr. Thomas Lanier DeLorme' training program was refined. Accordingly to Dr. DeLorme's recommendation the following intensities for assigned to each set: Set 1: 50% 10 rep max (RM), Set 2: 75% 10 RM, Set 3: 100% 10 RM. Dr. DeLorme advocated this approach as he felt the first couple sets should serve as warm-ups for the final max effort set of 10 reps., 3 times a wk for 4 weeks. Once the individual was able to lift greater than 10 reps on the final set, the weights were progressively increased. It is believed that it is the first method to provide exact intensity recommendations. This thus simply suggestive that isotonic resistance training by using all these delorme's parameter resulted in increase in isotonic strength.

So these studies can better provide the understanding and reasoning that why particular training improved its own strength gain. Further, results of our study had also been suggested that isokinetic training group, when subjected to isokinetic testing, showed most improvement and among isometric and isotonic training group, isotonic training group showed significantly more improvement .The significant difference between the above three training groups was only established by isokinetic testing.This above result of our study can be well explained by the two supportive facts. First fact is the principle of transfer of training. The Transfer Principle suggests that learning and performing one activity affects the performance of related skills and activities. This principle is based on the transfer of learning principle. Transfer of learning is defined as the influence of previous experiences on learning new skills or performing skills in new contexts. The positive effects in the transfer of training are explained on the basis of two theories. Also the second fact explaining our result very well is that it is well documented in the literature that isokinetic strength is the combination of isometric and isotonic strength. So that, it will result in improvement in isokinetic strength, when even isometric and isotonic strengthening are given. The reasoning and explanations for these above facts are also further being well furnished and defined in the literature.

In our study, isokinetic strength was increased after isotonic training, this happened because both as in isotonic contractions the load is constant but velocity changes and in isokinetic contraction, the velocity is constant but load changes. Both isokinetic and isotonic contractions are dynamic in nature. So muscle length in both of these contractions changes although both isotonic and isokinetic contractions have different biomechanical characteristics, but they both load the neuromuscular system. an increase in the no. and frequency of motor units has been observed after both isotonic and isokinetic strength training, so isokinetic strength might have been improved due to loading of neuromuscular system and because of the dynamic nature of isotonic training. [14]

Thus, by the supportive evidences, these above facts can further be well explained.

The study done by Dragana Golik1- Peric et al. 2011, the study was conducted to investigate the effects of 2 training protocols on isokinetic performance of athletes. Isokinetic testing of knee extensors and flexors was performed at 60 deg/sec. The athletes were divided into 2 groups. One group performed isokinetic training protocol and the second group followed isotonic training protocol. And then both protocols were tested after 4 weeks that is both groups underwent final isokinetic testing. The isokinetic strength significantly increases in after training in measure of peak torque in both extensors and flexors and in both the groups. This result showed that isokinetic strength improved significantly after giving isotonic training due to transfer of training effect. [15]In our study Isokinetic strength was increased after isometric training. This can be well explained. Isokinetic strengthening involves a constant speed of movement. But during this, muscle gains strength evenly all through the ROM and also the strength of a muscle varies at different angles as a result of the change in the angle of pull and perspective leverages. So after giving isometric training at multiple angles, the isokinetic strength also might have improved at those relevant angles, because the resistance in isokinetic strength also depends on the strength of quadriceps muscle at different angles in the ROM.

Thus, by supportive evidences, it can further be elaborated.

The study supporting our results was done by Jonathan P. Folland et al. Thirty-three recreationally active healthy males aged 18 – 30 years completed 9 weeks of strength training of the quadriceps muscle group three times per week. An intra-individual design was adopted: one leg performed purely isometric training at each of four joint angles (isometrically trained leg); the other leg performed conventional dynamic training, lifting and lowering (dynamically trained leg). Both legs trained at similar relative loads for the same duration. The quadriceps strength of each leg was measured isometrically (at four angles) and isokinetically (at three velocities) pre and post training. After 9 weeks of training, the increase in isokinetic strength was similar in both legs (pooled data from three velocities: dynamically trained leg, 10.7%; isometrically trained leg, 10.5%). Isometric strength increases were significantly greater for the isometrically trained leg (pooled data from four angles: dynamically trained leg, 13.1%; isometrically trained leg, 18.0%). This may have been due to the greater absolute torque involved with isometric training or a residual angle specificity effect despite the isometric training being divided over four angles. Isokinetic strength was improved significantly after isometric strengthening due to transfer of training. [16]

Also further our results showed that, when isokinetically tested, isotonic training group was improved more as compared to isometric training group. This can be easily understand as there occurs limited overflow in multiple angle isometrics on 10 degs either side in the ROM. Isometric procedures develop strength only in limited portions of the total range of motion, whereas isotonic procedures produce a more uniform development in muscle strength. Inspite of having the limited overflow in multiple angle isometrics another reason for its comparative inferiority is the angle specific variability. As the study done by Bandy and Hante et al. suggested that although by training at multiple angle i.e. 30, 45, 60, 90 isometrics improved strengths at that particular angle but there exists angle variability mean 30 degs was improved least and 90 degs was improved maximally. [13]These above findings can be better understood by evidences.

Jibi Paul et al. study showed the disadvantage of angle specificity of isometric training, at multiple angles in knee joint among normal adults. The objective of the study was to find out the effect of isometric strengthening exercise on strength of quadriceps at 45 and 90 degree of knee joint and also to compare the effect of strengthening exercise on strength of quadriceps at multiple angles of knee joint among control and experimental group. This was a comparative experimental study with forty female healthy subjects. The subjects were selected by inclusion criteria and randomly divided equally in to two with 20 subjects in each group. Isometric strengthening exercise and squatting exercise were given as intervention program for eight weeks respectively for experimental and control group. Pre and post data of quadriceps muscle strength measured were collected separately at 45 and 90 degree of knee joint using goniometry during resisted extension of knee in multi gym. Comparative study between experimental and control groups for quadriceps strength at 45 degree of knee joint found significant effect in increase of quadriceps strength. This study concluded that isometric strengthening exercise can improve quadriceps strength at 45 and 90 degree of knee joint. And also found that the strength at 90 degree has improved more compared to the strength at 45 degree. This nature of isometric supports might not be much effective in full ROM in increasing strength. [3]

**Functional performance**

In our study, only isotonic group showed significant improvement in functional performance with time from pre to post readings after 4 weeks of training. THDT (triple hope distance test)- for THDT, isotonic group improved more (9.2%) as compared to isometric group (2.61%) and isometric group improved more than isokinetic (2.13%). This result was supported by various similar facts and reasoning. According to Le-Brown et al. National strength and conditioning association, dynamic training improves functional performance as it involves movements in full range of motion, which are more natural and functional in contrast with both isometric and isokinetic exercises. A combination of concentric and eccentric dynamic muscle action is evident in countless tasks of daily life, such as walking up and down inclines, ascending and descending stairs, rising from a chair and sitting back down, or picking up or setting down an object. Hence, it is advisable to incorporate a variety of concentric and eccentric resistance exercises in a rehabilitation progression for functional performance of patients. For the average exerciser, the American College of Sports Medicine (ACSM), recommends doing one to three sets of eight to 12 repetitions of isotonic resistance exercise for all major muscle groups, performed twice weekly and it had also supported our result that isotonic strengthening improves functional performance in a better way. Our inferences are well supported by similar evidences. As in our study isotonic training was given in the form of DELORME'S technique of progressive resisted exercises. So the rigid protocol of PRE, itself found to have significant effect on functional performance.

Progressive Resistance Exercise in Physical Therapy: A Summary of Systematic Review Nicholas F Taylor et al. 2005 Progressive resistance exercise (PRE) is a method of increasing the ability of muscles to generate force. The purpose of this article was to review all the evidences on PRE as a physical therapy intervention. PRE shows moderate to large effect sizes that may carry over into an improved ability to perform daily activities. PRE were described by DeLorme and Watkins almost 60 years ago. PRE principles are (1) to perform a small number of repetitions until fatigue, (2) to allow sufficient rest between exercises for recovery, and (3) to increase the resistance as the ability to generate force increases. Training regimen starts with lower intensity loads so as not to harm the subjects and patients. This under dosing will also act like a warm up and percentage of the load then increased gradually so as to gain the successful outcomes.

So Traditionally, PRE has been used by young adults who are healthy to improve athletic performance. [17] Also study of P. Maietta Latessa et al. 2007 showed that isotonic training improves functional performance; Performance monitoring during isotonic leg training and analysis of movement was done. The aim of the study was to evaluate improvements during leg training on an isotonic leg extension system, the modality of exercise performance by building power-angle curves for each leg was analyzed. Ten subjects underwent a two-month training protocol on a leg extension device. Maximal theoretical forces were evaluated to set the protocols for each subject. Each training session was monitored in real time by the acquisition of angles and building power-angle curves for each leg during sub-maximal exercise. Maximal theoretical strength, maximal speed values and slopes between the first and last training sessions differed significantly. Constant monitoring of exercise performance allows physical training efficiency to be improved over time. Adequate training exercises can be devised by prompt analysis of movement by power-angle curves. The isotonic test for monitoring performance is a good solution directly correlated to isokinetic methodology. [18]

Also there are many reasons and explanation, which can be attributed to the facts that isometric training is not as good as isotonic training in increasing functional performance. According to Sagir G Bera et al. isometric exercises can significantly increase the tension of the muscle, thus the person can achieve maximum muscular contractions by performing isometric exercises in contrast to regular isotonic weight training. In addition to gains in muscle strength, isometric exercises can also lead to increase in muscle mass and improvements in bone strength. But the disadvantages are that it is performed in specific angle in a static position, so furthermore, person may experience decrease in speed and functional performance in contrast with the dynamic movements performed in dynamic training which is more functional isometric training can do so, but it improves muscle performance only at the joint angle at which the training takes place in that particular functional range. This specificity of training principle may limit how much isometric training can affect performance of functional tasks beyond the joint angle prescribed in the isometric training.

Also there is fact supporting that isokinetic training is not as effective as isotonic training in improving functional performance, this was explained in the manner, by inferences, suggesting that although having dynamic nature, isokinetic movements are always performed with same speed. So this can be attributed to the finding that isokinetic training is not much functional as isotonic training. This inference can be well synthesized by similar reference, in one study showing that several factors inherent in the design of most types of isokinetic equipment may limit the extent to which isokinetic training carries over to improvements in functional performance. Although isokinetic training affords a spectrum of velocities for training, the velocity of limb movement during many daily living and sport-related activities far exceeds the maximum velocity settings available on isokinetic equipment. In addition, limb movements during most functional tasks occur at multiple velocities, not at a constant velocity, depending on the conditions of the task. Furthermore, isokinetic exercise

usually isolates a single muscle or opposite muscle groups, involves movement of a single joint, is uniplanar, and does not involve weight bearing. Although isolation of a single muscle can be beneficial in remediating strength deficits in specific muscle groups, most functional activities require contractions of multiple muscle groups and movement of multiple joints in several planes of motion, some in weight-bearing positions.

## V. Conclusion

**From our study, it was concluded that;**

Isokinetic testing can establish the significant improvement in strength gains in all three training groups whereas isometric and isotonic testing can show improvement in their own type. Thus, isokinetic testing is the best way of strength testing. Among all three training modes, Isokinetic strength training can improve the strength maximally, so it is the best way of training as well. Isotonic strength training is the best way of increasing functional performance (triple hope distance test)

**Limitation**

Small sample size
Short duration of study
Stratified sampling should have been used.

## Recommendations

Further study should be replicated with-
Large sample size
Long duration of study
Stratified sampling should be used.
**Clinical utility-** Isokinetic testing and training both can be broadly used in clinical rehabilitation settings

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