

ORIGINAL RESEARCH

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EFFECTIVENESS OF CONCENTRIC AND ECCENTRIC RESISTANCE TRAINING OF QUADRICEPS AND HAMSTRINGS ON MUSCLE STRENGTH, ROM, AND PAIN IN ACL RECONSTRUCTED SUBJECTS

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ABSTRACT

Background: Ligament injury accounts for nearly 40% of all injury problems in anterior cruciate ligament injury constitute nearly 50% of all knee ligament injuries. Anterior cruciate ligament deficiency affects not only the mobility, self-confidence and lifestyle of the affected persons in short term but also causes arithmetic changes in the affected knee in the long run. Purpose of study to find the effectiveness of concentric and eccentric for post anterior cruciate ligament reconstruction subjects on muscle strength, joint range of motion and pain.

Methods: 24 samples with age group of 35 years were randomly assigned to two groups Concentric and Eccentric groups. The Concentric group, performed 9 (3sets) concentric contractions for knee extensors and 9 concentric contractions for knee flexor muscles. The eccentric group done 9 (3 sets) eccentric contractions for knee extensors and 9 eccentric contractions for knee flexors.

Results: Pain is significantly decreased in concentric group. But not significantly decreased in eccentric group ($t = 2.85$, $P = 0.009$; and $t = 1.40$; $P = 0.17$). The range of motion is significantly increased in both concentric knee extension and flexion and eccentric knee extension and flexion ($t = 3.53$, $P = 0.0023$; and $t = 4.55$; $P < 0.001$). The quadriceps muscle strength is significantly improved in both concentric and eccentric groups at $60^\circ / \text{sec}$ and $90^\circ / \text{sec}$.

Conclusion: The eccentric exercises are better than concentric exercises in improving the strength of hamstring and quadriceps muscles.

Key words: Concentric, Eccentric, Hamstring, Quadriceps, ACL.

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INTRODUCTION

The anterior cruciate ligament is major ligament out of eleven ligaments in the knee joint. They are termed as cruciate because they cross each other. The anterior cruciate ligament is the primary restraint to the anterior translation tibia in relation to femur and provides rotational stability.^{1,2}

It is the origin from the anterior part of the inter condylar of tibia and it extends superiorly, posteriorly and laterally.³ The anterior cruciate ligament is composed of an antero medially and postero lateral bundles, Intermediate bundle also described in the anterior cruciate ligament. The anterior cruciate ligament is pulled tightest in extension of the knee and in medial and lateral rotations also.^{4,5,6}

Ligament injury accounts for nearly 40% of all injury problems in anterior cruciate ligament injury constitute nearly 50% of all knee ligament injuries.^{7,8,9} Sports involving running activities such as foot ball, basket ball and base ball and other contact sports such as rugby contribute to the major cause of these injuries.^{10,11,12}

The anterior cruciate ligament injuries are divided into 3 grades. Grade-1 Pain with minimal damage to the ligament, Grade-2 More ligament damage and Grade-3 Completely torn and the joint are very loose (or) unstable.¹³

Incidence of ligament injury is on the average five times more likely in female athletes compared to male athletes due to intrinsic factors.^{14,15}

Anterior cruciate ligament deficiency affects not only the mobility, self confidence and lifestyle of the affected persons in short term but also causes arithmetic changes in the affected knee in the long run. In the time course after anterior cruciate ligament injury of medial meniscus.¹⁶

Reconstruction of anterior cruciate ligament is by far has better edge over or other methods of management with failure average of around 10%.¹⁷ Varieties of graft material and methods of fixations are available for surgery. Surgeon's choice such as auto grafts, allo grafts and synthetic graft materials.

Success rates of ligament reconstruction using auto graft are higher than allograft materials (or) synthetic graft materials were used.^{18,19} Success of anterior cruciate ligament reconstruction depends also on methods of graft fixation. Arthroscopic reconstruction of anterior cruciate ligament definite advantages over open reconstruction method. By far, two well accepted method of reconstruction are those involved in auto logos

bone patellar tendon bone (or) tripled quadrupled, hamstring tendons.

According to previous findings we hypothesized that a group of patient with anterior cruciate ligament receiving concentric- eccentric training would produce clinically meaningful improvement i.e. functions, increase range of motion and muscle strength and decrease the pain. We proposed to determine the effects of concentric versus eccentric isokinetic training on increased range of motion, increase the muscle strength and decrease the pain in patients with anterior cruciate ligament reconstruction.

According to BROTZMEN protocols the anterior cruciate ligament reconstruction subjects there is improvement in joint range of motion and muscle strength, decrease the pain. But my aim of the study is to prove the range of motion and muscle strength & pain may increase or decrease by the giving exercises with kin-com machine

There are five types of isokinetic machines present such as CYBEX range of dynamometer (Humac system), BIODEX dynamometer, KC 125AP, KC125 E, KC 500 H

In this study we use the KC 500 HEtc in this study the isokinetic anterior cruciate ligament reconstruction the isokinetic resistance training can give by using the isokinetic machine. Isokinetic dynamometer is the assessment of dynamic muscle strength and functional in general by measuring the joint motion and angular velocity movements.

METHODOLOGY

In this study 24 samples with age group of 35 years are collected from outpatient physical therapy department in BIRRD Hospital, Tirupati, are randomly assigned into two groups with fulfillment of four weeks after anterior cruciate ligament reconstruction, Unilateral anterior cruciate ligament reconstruction are included, any orthopedic problems in spine and lower limb, previous orthopedic surgery in lower limb, Peripheral vascular diseases, Cardiovascular abnormalities are excluded from study.

INTERVENTIONS

- The subjects were randomly assigned to two group's → Concentric, Eccentric groups.
- The Concentric group performed 9 (3sets) concentric contractions for knee extensors and 9 concentric contractions for knee flexor muscles.

- The eccentric group done 9 (3 sets) eccentric contractions for knee extensors and 9 eccentric contractions for knee flexors.

By using a spectrum of angular velocities ranging from 60° and 90° with 30° intervals. Three days a week for four week.

METHOD

- Test included measurement of height, weight and review of medical records such as cause of injury, associated injury and the four week's time intervals between the operation and isokinetic testing.
- Each subject underwent tests to measure isokinetic muscle strength at the knee while performing flexion-extension movements within involved lower limb the test were carried out using a (kin-com) isokinetic device in both concentric and eccentric modes.
- Subjects were seated with the back rest positioned at 90° angle and were instructed to grasp the sides of the seat of the seat during testing's. The thigh, pelvis and trunk were established with straps and adjustable lever arm was attached to the leg bay padded cuff just proximal to the lateral malleolus. The axis of rotation of the dynamometer arm was positioned with lateral; femoral condyle

OUT COME MEASUREMENTS

Knee pain

- Pain was subjectively evaluated using a 10-VAS (0-no pain, 10-unbearable pain) assessed severity of pain in general, after reconstruction and functional activities.

Muscle strength

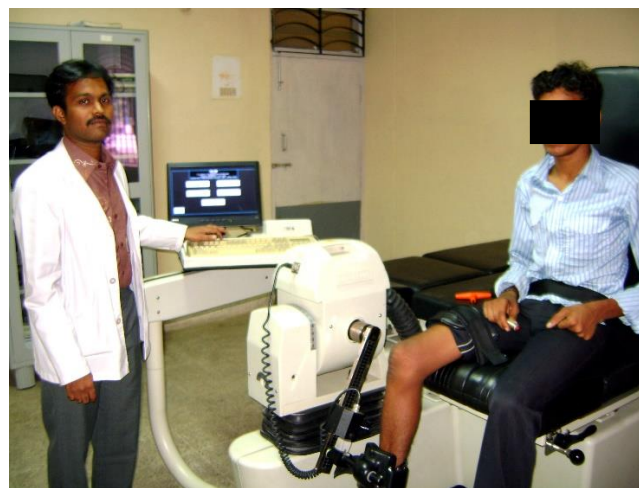
- The strength of the hamstrings and quadriceps was evaluated by using the KIN-COM machine in the way of peak torque.

Range of motion

- Knee range of motion was evaluated by the goniometry



Picture 1: Shows measuring knee range of motion with goniometer



Picture2: Shows concentric and eccentric exercises with isokinetic device

RESULTS

Table 1: Pre-test and Post test recordings of pain scale

Group	Pre-test	Post test	Statistical significance
Concentric	5.75 ± 1.14	4.42 ± 0.90	$t = 2.85;$ $P=0.009; S$
Eccentric	5.25 ± 1.22	4.50 ± 1.17	$t = 1.40;$ $P=0.17; NS$
Statistical significance	$t = 0.94;$ $P=0.35; NS$	$t = 0.17;$ $P=0.86; NS$	--

Compare with eccentric and concentric statistical analysis of pain table-1 shows the concentric group was significant. But the eccentric group was not significant.

Table 2: Difference between Pre-test and Post test recordings of pain scale

Group	Difference between pretest and post test	Statistical significance
Concentric	1.33 ± 1.07	$t = 0.81; P=0.42; NS$
Eccentric	0.75 ± 1.96	

Table 3: Pre-test and Post test recordings of Range (motion) during Flexion

Group	Pre-test	Post test	Statistical significance
Concentric	79.16 ± 9.49	95.5 ± 11.10	$t = 3.53;$ $P=0.0023; S$
Eccentric	80.00 ± 7.97	97.5 ± 9.17	$t = 4.55;$ $P<0.001; S$
Statistical significance	$t = 0.21;$ $P=0.83; NS$	$t = 0.43;$ $P=0.66; NS$	--

The statistical analysis of pre & post test of flexion joint range of motion is significant in both concentric and eccentric groups according to table-3.

Table 4: Pre-test and Post test recordings of Range (motion) during Extension

Group	Pre-test	Post test	Statistical significance
Concentric	79.16 ± 9.49	95.75 ± 10.59	$t = 3.68$; $P=0.001$; S
Eccentric	78.75 ± 9.56	97.5 ± 9.17	$t = 4.47$; $P<0.001$; S
Statistical significance	$t = 0.09$; $P=0.92$; NS	$t = 0.39$; $P=0.69$;NS	--

The statistical analysis of pre & post test of extension joint range of motions both concentric and eccentric groups are showing significant. In table- 4.

Table 5: Pre-test and Post test recordings of Quadriceps Muscle strength (60°/sec)

Group	Pre-test	Post test	Statistical significance
Concentric	67.17 ± 11.54	87.58 ± 11.25	$t = 5.18$; $P<0001$; S
Eccentric	64.83 ± 11.64	90.08 ± 18.54	$t = 3.64$; $P=0.0018$; S
Statistical significance	$t = 0.45$; $P=0.67$; NS	$t = 0.36$; $P=0.71$; NS	--

Table 6: Pre-test and Post test recordings of Quadriceps Muscle strength (90°/sec)

Group	Pre-test	Post test	Statistical significance
Concentric	57.92 ± 11.49	81.17 ± 12.10	$t = 4.40$; $P<0001$; S
Eccentric	52.42 ± 9.32	65.92 ± 12.80	$t = 2.69$; $P=0.014$; S
Statistical significance	$t = 1.17$; $P=0.25$; NS	$t = 2.73$; $P=0.013$; S	--

The table - 5, 6 shows the statistical analysis of Pre and post test values of quadriceps muscle strength is significant at 60° /Sec and 90°/Sec. in both concentric and eccentric groups.

Table 7: Pre-test and Post test recordings of Hamstring Muscle strength (60°/sec)

Group	Pre-test	Post test	Statistical significance
Concentric	66.17 ± 8.24	91.08 ± 12.28	$t = 5.32$; $P<0001$; S
Eccentric	80.17 ± 12.90	104.17 ± 18.44	$t = 3.37$; $P=0.0033$; S
Statistical significance	$t = 2.89$; $P=0.009$; S	$t = 1.88$; $P=0.078$; S	--

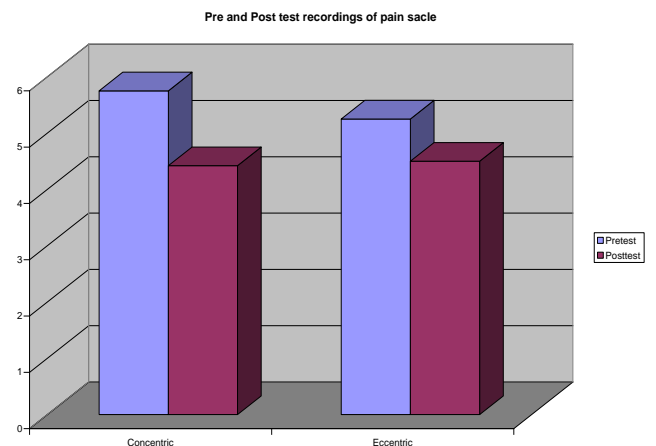
Table 8: Pre-test and Post test recordings of Hamstring Muscle strength (90°/sec)

Group	Pre-test	Post test	Statistical significance
Concentric	55.33 ± 10.59	79.50 ± 12.60	$t = 4.59$; $P<0001$; S
Eccentric	69.00 ± 16.07	90.08 ± 18.57	$t = 2.71$; $P=0.014$; S
Statistical significance	$t = 2.26$; $P=0.037$; S	$t = 1.49$; $P=0.15$;N S	--

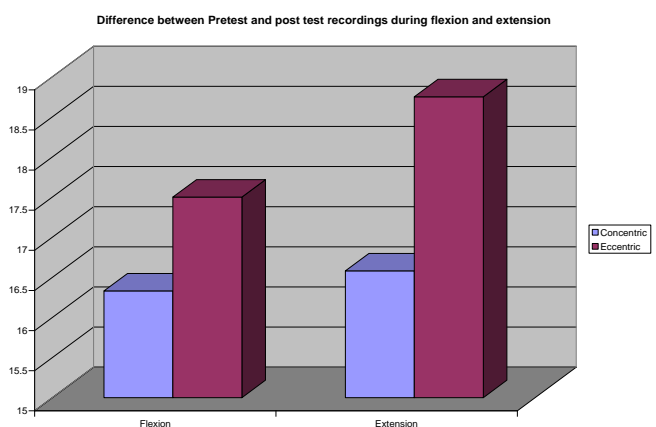
The statistical analysis of pre and post values of hamstring muscle strength of both concentric and eccentric muscle work at 60°/Sec and 90°/Sec significant (table - 7,8).

Difference between the pre and post test values of quadriceps muscle strength is significant in eccentric group. Non significant in concentric groups.

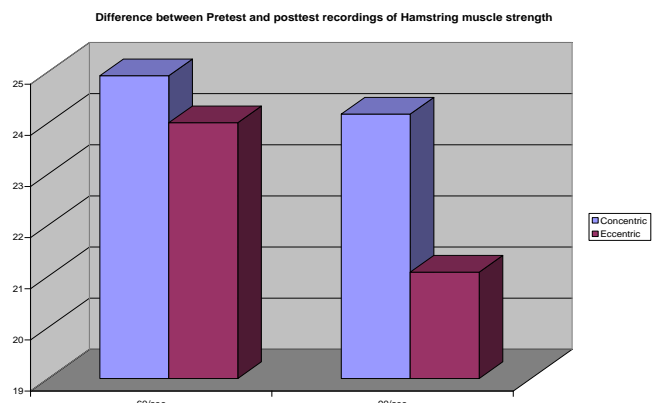
Difference between the pre and post test values of hamstring muscle strength is not significant in both concentric and eccentric.



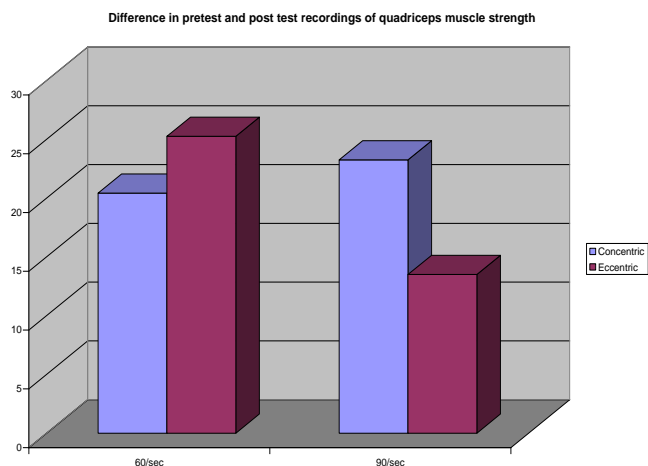
GRAPH 1: shows pre and post test pain scales for concentric and eccentric



GRAPH 2: shows pre and post test flexion and extensions for concentric and eccentric



GRAPH 3: shows pre and post test hamstring muscle strength for concentric and eccentric



GRAPH 4: Shows pre and post- test quadriceps muscle strength for concentric and eccentric

DISCUSSION

The discussion of the study was explaining the effectiveness of isokinetic concentric and eccentric exercise in anterior cruciate ligament reconstruction subjects. Table - 1 shows the pain is significantly decreased in concentric group. But not significantly decreased in eccentric group ($t = 2.85$, $P = 0.009$; and $t = 1.40$; $P = 0.17$). The range of motion is significantly increased in both concentric knee extension and flexion and eccentric knee extension and flexion ($t = 3.53$, $P = 0.0023$; and $t = 4.55$; $P < 0.001$) Apik JJ et. al (1983) and LIRC et. al (1996). The quadriceps muscle strength is significantly improved in both concentric and eccentric groups at $60^\circ / \text{sec}$ and $90^\circ / \text{sec}$. Tomberlin IP et. al (1991). Raymond Che Tinli et al., quoted that the quadriceps muscle strength is significantly improved in both concentric and eccentric groups. Kellis E, Baltzopoulos V proved that the quadriceps muscle strength is improved in both concentric and eccentric exercises. The hamstring muscle strength is improved in both concentric and eccentric group Gilselon sole et. al (1989). Zakas et al., found that the hamstring and quadriceps ratios various in different individual and different sports persons. Rosene J et al., found that the hamstring and quadriceps ratio is more effective at 60° and 90° . In my study the table 10 showing the quadriceps muscle strength is concentrically not significant. But eccentrically it is significant. Because the eccentric exercises are better than concentric exercises in improving the muscle strength.

CONCLUSION

Result of the present study showed that the eccentric exercises are better than concentric exercises in improving the strength of hamstring and quadriceps muscles.

REFERENCES

- Butler dl, Noyes fr, Grood es. Ligamentous restraints to anterior posterior drawer in the human knee. A bio-mechanical study J Bone Joint Surg Am. 1980; 62(2):259-270.
- Fukubayashi t, Torzilli pa, Sherman mf, Warren rf. An in vitro biomechanical evaluation of anterior-posterior motion of the knee. Tibial displacement, rotation and torque. J Bone Joint Surg Am. 1982; 64(2):258-64.
- John E. Hall. Guyton and Hall Textbook of Medical Physiology. 12^{Ed}, 2010.
- Nicholl jp, Coleman p, Williams BT. Pilot study of the epidemiology of the exercise related injuries. Injuries in sport and exercise sports council. 1991;25(1):61-66.
- Myasaka kc, Daniel d, Stone ml, et al. The incidence of knee ligament injuries in the general population. Am J Knee Surg. 1991; 4:3-8.
- S. Bollen. Epidemiology of knee injuries diagnosis and triage. Br. J. Sports Med. 2000; 34(3):227-228.
- Kujala u, Taimela s, Antti-poika-i, et al. Acute injuries in soccer, ice hockey, volley ball, basket ball, judo and karate; analysis of national registry data. BMJ. 1995; 311:1465-1468.
- Richard j, Dallalana, john h. M. Brooks, et al. Epidemiology of knee injuries in professional rugby. Amj Sports Med. 2007; 35(5):818-830.
- Mihata LC, Beutler AI, Boden BP. Comparing the incidence of anterior cruciate ligament injury in collegiate lacrosse, soccer, and basket ball players. Amj Sports Med. 2006; 34(6):899-904.
- Sung Gyu Moon, Sung Hwan Hong, et al. Grading Anterior Cruciate Ligament Graft Injury after Ligament Reconstruction Surgery: Diagnostic Efficacy of Oblique Coronal MR Imaging of the Knee. Korean J Radiol. 2008; 9(2):155-161.
- Ingram JG, Fields SK, Yard EE, Comstock RD. Epidemiology of knee injuries among boys and girls in US High School Athletes. Am j Sports Med. 2008; 36(6):1116-22.
- Gwinn DE, Wilckens JH, McDevitt ER, Ross G, Kao TC. The relative incidence of anterior cruciate ligament injury in men and women at the united states Navel academy. Am J Sports Med. 2000;28(1):98-102.
- Keene gc, Bickerstaff d, Rae pj, Paterson rs. The natural history of meniscus tears in anterior cruciate ligament in sufficiency. Amj Sports Med. 1993; 21(5):672-9.
- Von porat a, Roos em, Roos h. High prevalence of osteo arthritis 14 years after an anterior

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- cruciate ligament tear in male soccer players a study of radiographic and patient relevant outcomes. *Ann Rheum Dis* 2004; 63(3):269-273.
15. Lohmander ls, Ostenberg a, Englund m, et. al. High prevalence of knee osteoarthritis, pain and functional limitations in female soccer players twelve years after anterior cruciate ligament injury. *Arthritis Rheum* 2004;50(10): 3145-3152.
16. D.e.Meuffels et al. Ten years follow up study comparing conservative versus operative treatment of anterior cruciate ligament ruptures. A matched pair analysis of high level athletes. *Br. J. Sports Med.*2008;43(5):347-351.
17. Hugueslouboutin et al. Osteo arthritis in patient with anterior cruciate ligament rupture: a review of risk factors.*The knee.*2008; 16(4):239-244.
18. Noyes fr, Mooar pa, Matthews ds, Butler dl. The symptomatic anterior cruciate ligament deficient knee. Part-I: the long - term functional disability in athletically active individuals. *J Bone Joint Surg Am.*1983; 65(2):154-162.
19. Maletis, sheril. Cameron, joann j. Tengan and raoul j. Burchette. A prospective randomized study of anterior cruciate ligament reconstruction: a comparison of patellar tendon and quadruple-strand semitendinosus/gracilis tendons fixed with bioabsorbable interference screws. *B.Amj Sports Med.* 2007; 35(3):384-94.

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