



Effect of rehabilitation exercises on the range of motion of the knee joint following anterior cruciate ligament reconstruction

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Abstract

This study aims to determine the effect of rehabilitation exercises following anterior cruciate ligament reconstruction (ACLR) on range of motion (ROM). The study sample included 9 injured athletes in Aurangabad city, Maharashtra, India, who had undergone ACLR and unable to return to practice their sports activities within first year after primary ACLR. The experimental method was used through applying the pre and post measurements due to its appropriate to investigate the purpose of study. The results of this study showed that the rehabilitation exercises have highly significant improvement in all range of motion variables (active flexion, passive flexion, active extension, and passive extension) following ACL reconstruction.

Keywords: rehabilitation exercises, rang of motion (ROM), anterior cruciate ligament reconstruction (ACLR)

Introduction

Knee joint is the largest synovial joint in the human body and it is a mobile functional anatomical unit which plays a key role in sport and recreation, but its functional anatomical composition makes it a more vulnerable to injury, also the knee joint located between the long bones of the body, femur, tibia and patella in interior surface which provide the injury occurrence possibility in any point contact with each other (Anderson M. *et al*, 2000)^[6]. Knee injuries are prevalent among a variety of competitive sports and can impact an athlete's ability to continue to participate in their sport or in the worst case, end an athlete's career (Weiss K., & Chris W., 2015)^[40]. Knee joint the most frequently undergoing to reconstruction surgeries, especially of repair and rebuild an anterior cruciate ligament tear among the most economically costly sports injuries, habitually requiring expensive surgery and rehabilitation (Joseph A. *et al*, 2013) (Rosemont I., 2015)^[34].

Anterior cruciate ligament (ACL) is one of a pair of the cruciate ligaments in the human knee (Agur A., 2015)^[3]. It is a broad ligament joining the anterior tibial plateau to the posterior femoral intercondylar notch (Satpathy G., 2005)^[35]. ACL is composed of two bundles - anteriomedial and posteriolateral - and it provides 85% of restraining force against anterior translation and medial rotation between tibia and femur (Kisner C. & Colby L., 2002)^[27] (Ramachandran M., 2006)^[33] (Isberg J., 2008)^[22].

Anterior cruciate ligament reconstruction (ACLR) is an agreed and designed surgical technique for ACL injuries by arthroscopically and it is becoming now preferred method in treatment of ACL rupture around the world in increasing numbers (Vaishya R. *et al*, 2015)^[38] (Delincé P., & Ghafil D., 2012)^[11]. ACLR has remained the current standard among the most common sports medicine procedures of care for treatment of ACL injuries in active patients, particularly for young individuals and athletes who aim to return to high level sports activities (Kiapour A., & Murray M., 2014)^[25] (Hewett T. *et al*, 2013)^[9].

ACL reconstruction surgery usually results to occur some complications that may lead to greater functional deficits and delay recovery process such as pain around the knee, loss of range of motion, quadriceps weakness, recurrent injury and associated osteoarthritis (Kartus J. *et al*, 1999)^[23] (Carneiro M. *et al*, 2015)^[10] (Micheo W. *et al*, 2010)^[30]. These complications can range from minor and inconsequential to severe, additionally the complication rates are a low with arthroscopic technique that can be performed safely in ACL reconstruction surgery (Andrés-Cano P. *et al*, 2015)^[7]. An appropriate postoperative rehabilitation process is so vital to prevent these complications and the key to successful ACL reconstruction surgery (Manske R., 2006)^[29].

Rehabilitation process after ACL surgery is a point of crucial importance in the treatment program to achieve desired good functional outcomes that regarded the goals of both nonoperative and postoperative rehabilitation (Heijne A., & Werren S., 2007)^[17] (Görmeli G. *et al*, 2015)^[14].

Rehabilitation protocol following ACL surgery must be corresponded with surgical technique results in measurement outcome after surgery and functional recovery to pre-injury (Dragicevic-Cvjetkovic D. *et al*, 2014)^[12].

Rehabilitation after ACL surgery needs to monitor some performance indicators by undertaking some measurements relate to knee functions or some body function which can be used to determine rehabilitation program progression in recovery knee joint and restore athlete's status preinjury for return to participate in sport competitions and daily living activities (Herrington L. *et al*, 2013)^[18].

Current rehabilitation programs after anterior cruciate ligament reconstruction (ACLR) for return to sport is quite disparate and indistinct because depending on personal interpretation and lack of clear empirical standard guidelines aimed to achieve task specific objectives for progression within the rehabilitation

literature (Schmitt L. *et al*, 2012)^[36] (Herrington L. *et al*, 2013)^[18].

The magnitude of the problem is clear, as a high incidence of ACL injury, particularly in young athletes. Recent evidence suggests that more than half of athletes who undergo ACL surgery are unable to return to their preinjury level of function after ACLR surgery. Return to sports activities remains a very difficult topic. Thus the research regarding the rehabilitation process of athlete after ACL surgery continues to evolve (Paterno M., 2015)^[32].

Although studies have been conducted to investigate in the effects of rehabilitation exercises on range of motion following ACL reconstruction that mentioned in literature review, but the rehabilitation process remains controversial issue needs to conduct further studies in order to early return for the injured athletes to high-level competitive sports.

Objective of Study

This study aims to determine the effect of rehabilitation exercises following anterior cruciate ligament reconstruction (ACLR) on range of motion (ROM) through comparative between pre and post measurements.

Hypothesis of Study

There is a significant difference between pre and post measurements of range of motion (ROM) following anterior cruciate ligament reconstruction in favor of post measurement.

Methodology

The study used the experimental method through investigate in effect of rehabilitation exercises by using the pre and post measurements following ACL reconstruction.

Subjects of Study

The study sample was purposely selected to include 9 injured athletes in Aurangabad city, Maharashtra, India, who had undergone ACL surgery and unable to return to full participation in sports activities at same their previous preinjury level within first year after primary ACLR. To verify the homogeneity of the study sample was investigated some demographics represent sharing common characteristics of study sample such as sex, age, height, weight, etc. These characteristics in study sample should be equivalent in order to achieve their homogeneity.

Table 1: Demographic characteristics of study sample (N = 9)

Variables	Unit	Mean	S. D	Skewness
Age	Year	23.56	3.005	0.196
Height	Cm	172.78	7.311	- 0.678
Weight	Kg	75.24	7.436	0.179

The table (1) shows that there is no significant difference in

demographic characteristics (age, height, weight) of study sample. All skewness values are limited between -3 and +3, which clearly indicated to homogeneity of study sample, thus it is acceptable to conduct this study.

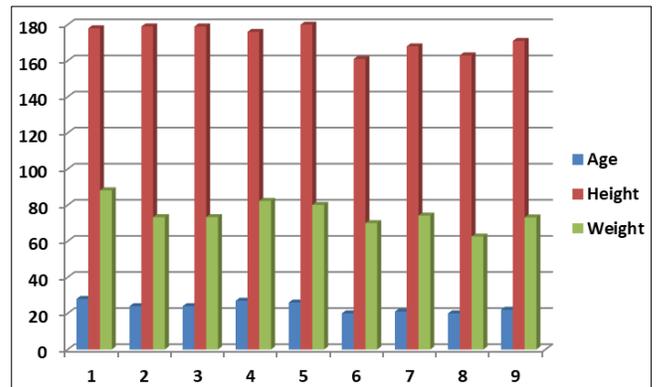


Fig 1: Mean difference of demographic characteristics of study sample (N = 9)

Rehabilitation Exercises

The rehabilitation exercises have been designed through review some previous studies in ACL rehabilitation after surgery. The rehabilitation exercises included most commonly exercises in modern standard rehabilitation programs after ACL reconstruction surgery, which divided into five stages for period of twelve weeks. Each week consisted five sessions. Session time ranged between 45 to 60 minutes with progress of rehabilitation stages according to the fifteen experts' opinions in physiotherapy and sports injuries rehabilitation field. The rehabilitation exercises have been executed from May 1st to July 31st, 2014 in playgrounds and gyms of M.S. M's College of Physical Education, Aurangabad, Maharashtra, India.

Tools and Means of Measurements (Materials Used)

The tools and means were tested in the pilot study and were shown to be accurate and reliable, which included the following:

- a. Stadiometer to measure the height (cm).
- b. Electronic weighing machine to measure the weight (kg).
- c. Goniometer to measure the range of motion of the knee joint (degree).

Statistical Analysis

The data of present study were analyzed by using SPSS statistical software package (version 22). Mean values, standard deviations and skewness were calculated to verify the demographic characteristics of study sample, then T-test was calculated to determine the differences between pre and post measurements after 12 weeks of rehabilitation, the (P≤0.05) level of probability is accepted as a criterion of statistical significance.

Results and Discussion

Table 2: Significant differences in range of motion variables between pre and post measurements (N=9)

Variables	Pre		Post		Mean Difference	T-test	P-value
	Mean	S. D	Mean	S. D			
Active Flexion	67.67	5.431	42.89	3.919	-24.780	11.0999	0.0001
Passive Flexion	60.00	4.416	33.11	4.512	-26.890	12.7776	0.0001
Active Extension	122.78	10.134	171.00	4.416	48.220	13.0862	0.0001
Passive Extension	131.44	10.910	176.78	2.587	45.340	12.1311	0.0001

The table (2) shows that there is significant improvement in range of motion of the injured knee joint after 12 weeks of proposed rehabilitation program. The mean difference between pre and post measurements of proposed rehabilitation program in active range of motion flexion and passive range of motion flexion are (-24.780 and -26.890) respectively. While active range of motion extension and passive range of motion extension are (48.220 and 45.340) respectively in favor of post measurement. There is statistically significant difference at level ($p \leq 0.05$) between pre and post measurements in all range of motion variables (0.0001).

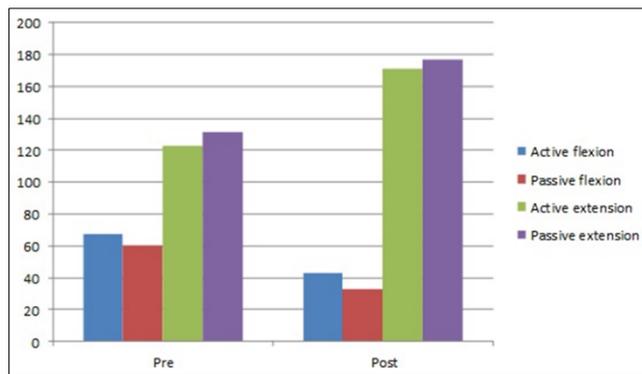


Fig 2: Mean difference in range of motion variables between pre and post measurements (N=9)

The results of this study showed that the rehabilitation exercises have highly significant improvement in all range of motion variables following ACL reconstruction. There is significant improvement between pre and post measurements in range of motion variables (active flexion, passive flexion, active extension, and passive extension). While in post measurements the rehabilitation exercises program has positive effect on increasing all range of motion under study. Therefore the superiority in post measurements due to the rehabilitation exercises collected most exercises that mentioned in recent standard rehabilitation programs after ACL reconstruction surgery such as range of motion and muscle strength exercises, walking, running, ergometer cycle, treadmill, balance exercises, resistance exercises from different angles (leg press machine), passive exercises and leg press machine by using different weights gradually. These results accepted by several previous studies which were done in rehabilitation after ACL surgery. (Abdulzahir M., 2013)^[1] observed that the rehabilitation program by using dynamic balance exercises impacted in increase range of motion (ROM) following ACL reconstruction surgery of athletes and helped them to return to their sports activities. (Haggag A., 2013)^[16] mentioned that the passive rehabilitation exercises for 12 weeks led to improve flexion and extension range

of motion (FROM and EROM) after arthroscopic ACL reconstruction and there was varying effects on return of the injured limb to its normal case. (Awadallah A., 2012)^[8] indicated that the 3 months rehabilitation program using aquatic resistance training led to regain ROM of knee (flexion, extension) after ACL surgery. (Al-Rufidy M., 2007)^[4] found significant difference in active and passive ranges of motion after ACLR surgery. (Hooper D. *et al.*, 2001)^[20] reported that greatly improved results using the accelerated rehabilitation program (CKC), including greater return of knee extension, strength and maintaining stability after ACL reconstruction surgery. (Ibrahim F., 2013)^[21] concluded that the isometric and dynamic rehabilitation exercises led to restore range of motion (ROM) of infected knee after internal ligaments surgery. (Mohammed M., 2013)^[31] showed that the rehabilitation range of motion and muscle strength exercises after arthroscopic anterior cruciate ligament reconstruction (AACL) had led to improve functional stability through increase muscle strength and range of motion (ROM). (Awdat M., 2012)^[9] demonstrated that the rehabilitation program using strength exercises after ACL rupture has positive influence on regaining flexion and extension range of motion (FROM and EROM) of the knee joint compared with the intact knee joint. (Tagesson S., 2008)^[37] explained that the gradual increase range of motion (ROM) starts in early rehabilitation stage due to reduce swelling and regular rehabilitation stages after ACL injury or surgery lead to reduce swelling gradually, thus increase range of motion (ROM). (Amin A., 2014)^[5] demonstrated the proposed rehabilitation program by using resistance training led to restore range of motion (AROM and PROM) and return to normal functional efficiency of injured knee compared with intact knee. (Abu Al Saud K., 2012)^[2] reported the physical therapy which consisted active and passive exercises has positive impact on increase range of motion (FROM and EROM) of knee joint and raise the functional efficiency of body joints. (Kidd M., & Viswanathan P., 2010)^[26] revealed that the standard physiotherapy alone has more valuable than CPM to improve ROM of knee function following total knee arthroplasty. (Elsayad H., 2011)^[13] found that the isometric and dynamic rehabilitation exercises have led to improve range of motion (flexion and extension) and functional ability after AACL. (Grinsven S. *et al.*, 2010)^[15] demonstrated that the accelerated rehabilitation protocol led to regain range of motion (ROM) and muscle strength following ACLR. (Villa S. *et al.*, 2010)^[39] cleared that the sport-specific rehabilitation protocol had positive effect on improve the knee extension, knee flexion and muscles strength for soccer players after ACLR surgery. (Kelln B. *et al.*, 2009)^[24] reported that the active rehabilitation exercises on a bicycle ergometer led to improve ROM and to promising results in patients after partial meniscectomy. (Mahmoud M., 2007)^[28] concluded that the proposed program which included muscle

strength exercises and passive range of motion exercises has positive improvement in range of motion (flexion and extension) and return of the normal functions for the injured knee joint after total knee replacement. It can be emphasized that the rehabilitation exercises had included most rehabilitation exercises which has been mentioned previously, this proved superior effect of rehabilitation exercises, thus the hypothesis has been fully achieved.

Conclusions

The rehabilitation exercises had a highly effective in increasing all in range of motion variables (active flexion, passive flexion, active extension, and passive extension) after 3 months following anterior cruciate ligament (ACL) reconstruction.

Recommendations

The design of rehabilitation exercises following ACL reconstruction should be based on scientific and clinical research and focus on specific drills and exercises designed to return the injured athletes to the desired functional goals. Develop the proposed rehabilitation program by addition of some therapeutic modalities (e.g., CPM., faradic simulation, ultrasound, etc.). Apply the proposed rehabilitation program on athletes after ACL surgery, who returned to their sports activities after rehabilitation, but they unable to participate in competitions as same their functions and skills levels preinjury. Focus on adding some prevention exercises to rehabilitation program with theory lessons about ACL injury risk factors and prevention to avoid injury recurrence and to safe return to sports participation. Increase sample of the study to provide a higher representation of the characteristics of the society for results to be credible. Conduct comparative study between males and females athletes after ACL reconstruction.

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