

CLINICAL IMPLICATION OF GAIT KINEMATICS IN REHABILITATION PROGRAMME OF WRESTLERS WITH ACL INJURY

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ABSTRACT

It was well established in researches that joints angles adapt to locomotion at different velocity, few of them researches has focused the variation in joints angular velocity. There is currently no study to examine clinical implication of gait kinematics in rehabilitation programme especially ACL grade II injured wrestlers. Thus, 15 ACL-grades II injured wrestlers underwent 2D-dimensional gait analysis while walking pre and post rehabilitation program. The peak joint angular velocities during important phases of the gait cycle were examined for the hip, knee and ankle in the sagittal plane. Paired sample t test and Cohend'd test were used to compare pre and post rehabilitation with effect size. Results of the study showed significant mean differences exist between pre-test and post-test of rehabilitation program of ACL injured wrestlers. Results of study revealed that kinematic variables hip, knee and ankle joints angular velocity showed statistically significant means differences exist between pre-test and post-test of rehabilitation program of injured wrestlers with medium to high effect size respectively. The results of the study showed that the rehabilitation programme play significant role in order to reach normalization Hip, Knee and ankle joints angular velocity at standard velocity of gait pattern which was reported in above mentioned studies.

Keywords: GAIT Kinematics, rehabilitation, wrestlers, ACL injury.

1. INTRODUCTION

Break of the anterior cruciate ligament (ACL) is a general injury in sports such as netball, basketball, rugby, wrestling, and soccer, and is particularly common along with young adults. The ACL injury has an enormous impact not only on an individual but also on their family, work, and quality of life. Rupture to the ACL predisposes the individual to an increased risk of early onset of degenerative changes (Porat, Roos, & Roos, 2004). Of those suffering an ACL injury, 50-70% have symptoms associated with post-traumatic osteoarthritis 10 years following the injury (Lohmander, Englund, Dahl, & Roos, 2007). As these injuries have the highest rate for people below 30 years of age, by the time they reach 40, approximately 50% of those injured individuals are likely to have signs of knee osteoarthritis. It is essential to understand the potential outcomes of an ACL injury, as it is associated with high levels of impairment and represents a long-term burden on the health system and for the individual.

The ACL injuries are treated with non-surgical management or surgery. Surgical treatment aims to allow the patient to return to sports, and to restore knee function as optimally as possible. Reconstruction of the ACL is commonly associated with two primary outcomes:

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firstly, the risk of re-injury on return to physical activity and sport (Paterno, Rauh, Schmitt, Ford, & Hewett, 2012), and secondly, the early onset of post-traumatic osteoarthritis in the long-term (Lohmander, Englund, Dahl, and Roos, 2007). Clinical assessment and treatment methods replicate joint angular velocity during walking; an understanding of a healthy cohort walking at various speeds is required to allow investigation of deviations from normal. Therefore, the aim of the current study was to examine lower limb joint angular velocities for sagittal plane movements in a ACL grade injured wrestlers pre and post-test walking.

2. METHODS AND MATERIALS

2.1 The Subjects

Fifteen (15) male elite wrestlers (18 to 24 years of age) with Grade-II ACL injury from Republic of Iraq were selected for the study. All the selected players have readily agreed and volunteered to act as subject for the study.

2.2 Study Protocol

Grade -II ACL with no other ligaments and cartilages involved, the associated pain and dysfunction can be treated with exercise/ physical therapy. In the first stage of the injury physical therapist mainly focus on rest and anti-inflammation measures. As swelling resolved physical therapist/researcher focus to restore normal range of motion and strengthening of knee joints/muscles. Ten (10) week non-surgical management program i.e. ROM and Flexibility, Muscles strength and flexibility, Proprioceptive/balance, Gait and cardio were used to rehabilitate ACL-II grade knee injury.

2.3 Video-graphic Equipment and location

The subject's walking motion were recorded using two synchronized Nikon D-7000 video camera in a field setting. The cameras were set-up on a rigid tripod and secured to the floor in the location. In order to obtain maximum accuracy in the reconstruction of the two-dimensional co-ordinates, the location of the cameras was chosen in such a way that the optical axes of the intersected perpendicularly on both planes namely sagittal plane and frontal plane.

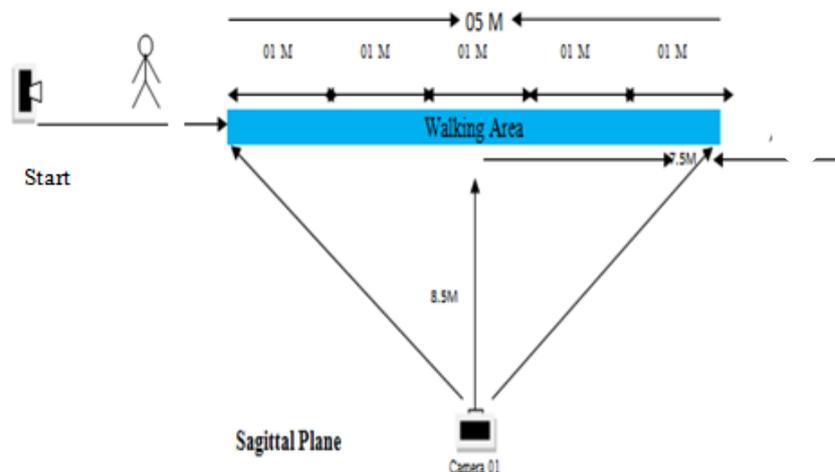


Figure 1: Experimental Setup

The camera was positioned 8.5 meter perpendicular to the sagittal plane and parallel to the mediolateral axis (camera optical axes perpendicular on the sig plane) as their walking side giving approximately a 90° between their respective optic axes,

Other camera was positioned (8) meter behind the stationary position, initial position with the camera's optical axis perpendicular to the frontal plane for measuring the upper and lower body segment motion of subjects during various phases and sub phases of Gait. The camera was also elevated (1.10 meter) and tilted in order to get the image of the as large as possible while that all points of interested remained totally within movement,

2.4 Camera Speed and Synchronization

The camera was set at sports mode and the sampling rate of the video camera was sixty (60) fields per second. The shutter speed of the camera was fixed at fast speed (1/2000 fast shutter speed allow fast-moving subject. A fast shutter speed can freeze the motion of a fast-moving subject and a slow shutter speed can blur the subject to give the impression of the motion.

2.5 Data Reduction and Analysis

The video-graphic data were collected after the complete rehabilitation sessions time to time according schedules which were prepared by the researcher. After video recording sessions were recording in to the researcher's personal computer and laptop for trail identification. The identified trails were played with the help of software Silicon Coach Pro 8 (SCP) to make separate clips of each player for separate Gait phases. This software provides to identify the angles, velocity (linear and angular), cadence, step length stride length, and number of frames.

3. RESULTS

The main purpose of this examination was to find out the clinical implication of rehabilitation program on selected kinematic of Gait pattern of elite wrestlers with knee injury. Paired Samples t -test was used to investigate the mean differences in hip joints angular velocity (⁰/s) of Gait, between pre and post rehabilitation program of injured wrestlers.

Table 1: Comparison of hip joints angular velocity between pre and post rehabilitation program

	Paired Differences			t	p-value	Cohen's <i>d</i>
	Mean	Std. Deviation	Std. Error Mean			
Hip Extension Loading Response (Pre- Post)	-14.80	15.3	3.96	-3.73	0.00*	0.96
Hip Flexion Pre-Swing (Pre- Post)	-21.53	16.79	4.33	-4.97	0.00*	1.28
Hip Extension Terminal Swing (Pre- Post)	-4.33	6.41	1.65	-2.62	0.02*	0.67

Degree of freedom= 14

**p<0.05*

Results of Table 1 reveal that kinematic variables, hip extension loading Response (HELRL) ($t = -3.73, p = 0.002, p < 0.05$), hip flexion pre swing (HFPS) ($t = -4.97, p = 0.000, p < 0.05$) and hip extension terminal swing ($t = 2.62, p = 0.02, p < 0.05$) showed statistically significant means differences exist in hip joints angular velocity between pre-test and post-test of rehabilitation

program of injured wrestlers. The value of Cohen's *d* were hip extension loading response (HELR) 0.96 (> 0.80) and hip flexion pre swing (HFPS) 1.28 (>0.80) which indicated large effect size and hip extension terminal swing (HETS) value of Cohen's *d* was 0.67 (>0.50) which indicated Medium effect size.

Table 2: Comparison of knee joints angular velocity between pre and post rehabilitation program

	Paired Differences			t	p-value	Cohen's <i>d</i>
	Mean	Std. Deviation	Std. Error Mean			
Knee Flexion Loading Response (Pre- Post)	-20.46	21.02	5.42	-3.77	0.00*	0.97
Knee Extension Terminal Swing (Pre- Post)	-10.33	15.47	3.99	-2.58	0.02*	0.69
Knee Flexion Pre-Swing (Pre- Post)	-23.53	26.64	6.87	-3.42	0.00*	0.88
Knee Extension Terminal Swing (Pre- Post)	-13.73	22.42	5.79	-2.37	0.03*	0.61

Degree of freedom= 14

**p<0.05*

Results of Table 2 reveal that kinematic variables, knee flexion loading response (NFLR) ($t=-3.77$, $p=0.00$, $p<0.05$), knee extension terminal stance (KETS) ($t=-2.58$, $p=0.022$, $p<0.05$), knee flexion swing (KFS) ($t=-3.42$, $p=0.00$, $p<0.05$) and knee extension terminal swing (KETS) ($t=-2.37$, $p=0.03$, $p<0.05$) showed statistically significant means differences exist in knee joints angular velocity between pre-test and post-test of rehabilitation program of injured wrestlers. The value of Cohen's *d* were knee flexion loading response (KFLR) 0.97 (>0.80) which indicated large effect size, knee extension terminal stance (KETS) 0.69 (>0.50) which indicate medium effect size, knee flexion swing (KFS) 0.88 (> 0.80) which indicated large effect size and knee extension terminal swing (KETS) 0.61 (>0.50) which indicate medium effect size.

Table 3: Comparison of knee joints angular velocity between pre and post rehabilitation program

	Paired Differences			t	p-value	Cohen's <i>d</i>
	Mean	Std. Deviation	Std. Error Mean			
Ankle Plantarflexion Loading Response (Pre-Post)	-9.80	11.83	3.05	-3.20	0.01*	0.82
Ankle Dorsiflexion Mid-stance (Pre-Post)	-10.06	13.51	3.49	-2.88	0.01*	0.74
Ankle Plantarflexion Pre-swing (Pre-Post)	-38.26	20.78	5.36	-7.12	0.00*	1.84
Ankle Dorsiflexion Mid-Swing (Pre-Post)	-16.40	16.10	4.15	-3.94	0.00*	1.01

Degree of freedom= 14

**p<0.05*

Results of Table 3 reveal that kinematic variables, ankle plantar flexion loading response (APFLR) ($t=-3.20$, $p=0.01$, $p<0.05$), ankle dorsiflexion mid-stance (ADM) ($t=-2.88$, $p=0.01$, $p<0.05$), ankle plantar flexion pre-swing (APP) ($t=-7.12$, $p=0.00$, $p<0.05$), and ankle

dorsiflexion mid-swing (ADMS) ($t=-3.94$, $p=0.00$, $p<0.05$) were showed statistically significant means differences exist in ankle joints angular velocity between pre-test and post-test of rehabilitation program of injured wrestlers. The value of Cohen's d were Ankle Plantar flexion Loading Response 0.82 (>0.80) which indicated large effect size, ankle dorsiflexion mid-stance (ADM) 0.74 (>0.50) which indicate medium effect size, ankle plantar flexion pre-swing (APP) 1.84 (>0.80) and ankle dorsiflexion mid-swing (ADMS) 1.01 (>0.80) which indicated large effect size.

4. CONCLUSION

Comparative analysis was used to investigate the mean differences in hip, knee and ankle joints angular velocity ($^{\circ}/s$) of Gait, between pre and post rehabilitation program of ACL injured wrestlers. Results of study revealed that kinematic variables, hip extension loading Response, hip flexion pre swing and hip extension terminal swing showed statistically significant means differences exist in hip joints angular velocity between pre-test and post-test of rehabilitation program of injured wrestlers. The value of Cohen's d was hip extension loading response and hip flexion pre swing which indicated large effect size and hip extension terminal swing which indicated Medium effect size. Result of the study revealed that the significantly increased hip extension loading from 116.93 $^{\circ}/s$ to 131 $^{\circ}/s$, hip flexion pre swing 175.06 $^{\circ}/s$ to 196.60 $^{\circ}/s$ and hip extension terminal swing 29.80 $^{\circ}/s$ to 34.13 $^{\circ}/s$ with 1.01 and 1.13 m/s gait velocity respectively. Results of the present study in line with the previous study (Mentiplay et al., 2018; Umberger, & Martin, 2007).

Results of the study reveal that kinematic variables, knee flexion loading response, knee extension terminal stance, knee flexion swing and knee extension terminal swing showed statistically significant means differences in knee joints angular velocity between pre-test and post-test of rehabilitation program of injured wrestlers. The value of Cohen's d was knee flexion loading response which indicated large effect size, knee extension terminal stance which indicate medium effect size, knee flexion swing which indicated large effect size and knee extension terminal swing which indicate medium effect size (Winter et al, 1994). Result of the study reveal that the significantly increased knee flexion loading response from 107.86 $^{\circ}/s$ to 128.33 $^{\circ}/s$, knee extension terminal stance from 66.33 $^{\circ}/s$ to 76.66 $^{\circ}/s$, knee flexion swing from 304.40 $^{\circ}/s$ to 327.93 $^{\circ}/s$ and knee extension terminal swing from 363.40 $^{\circ}/s$ to 377.13 $^{\circ}/s$ with 1.01 and 1.13 m/s gait velocity respectively in line with the study (Umberger, & Martin, 2007; Mentiplay at el., 2018). Results of study revealed that kinematic variables, ankle plantar flexion loading response, ankle dorsiflexion mid-stance, ankle plantarflexion pre-swing, and ankle dorsiflexion mid-swing were showed statistically significant means differences exist in ankle joints angular velocity between pre-test and post-test of rehabilitation program of ACL injured wrestlers. The value of Cohen's d was Ankle Plantarflexion Loading Response which indicated large effect size, ankle dorsiflexion mid-stance which indicate medium effect size, ankle plantar flexion pre-swing and ankle dorsiflexion mid-swing which indicated large effect size. Result of the study reveal that the significantly increased ankle plantar flexion loading response from 91.33 $^{\circ}/s$ to 101.13 $^{\circ}/s$, ankle dorsiflexion mid-stance from 77.80 $^{\circ}/s$ to 87.86 $^{\circ}/s$, ankle plantar flexion pre-swing from 284.86 $^{\circ}/s$ to 323.13 $^{\circ}/s$ and ankle dorsiflexion mid-swing from 162.33 $^{\circ}/s$ to 178.73 $^{\circ}/s$ with 1.01 and 1.13 m/s gait velocity respectively. Present results in line with the previous study reported by (Mentiplay et al., 2018; Winter, Eng, & Isshac, 1994). The results of the study showed that the rehabilitation programme play significant role in order to reach normalization Hip, Knee and ankle joints angular velocity at standard velocity of gait pattern which was reported in above mentioned studies.

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