

The Functional Abilities and Maximal Vertical Jumping Height in Coper and Non-coper Anterior Cruciate Ligament-Deficient Knee

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Objectives: The aim of the present study was to compare the performance of the vertical jump task and the level of disability between the coper and non-coper athletes with an anterior cruciate ligament-minus knee.

Methods: Thirty-four professional male athletes with isolated complete anterior cruciate ligament -tear (age 20-29 years and 6-12 months time past injury) were recruited in this study. The subjects were allocated into the coper (n=17) and non-coper (n=17) groups according to their history of having giving way and feeling an instability in their injured knee. The maximum vertical jump height was recorded by a 6-camera Vicon motion analysis system. The functional outcomes of the subjects were assessed with use of the Persian versions of the International Knee Documentation Committee, Knee Injury and Osteoarthritis Outcome Score and Tegner Questionnaires.

Results: The results revealed that the coper ACL-deficient knee subjects had a significantly higher International Knee Documentation Committee score as well as two subscales of the KOOS questionnaire including the sports (p=0.001) and the quality of life (p=0.016) than non-copers. However, the subscales of pain (p=0.0137), symptoms (p=0.353) and the activities of daily living (p=0.133) of the KOOS questionnaire did not show any significant differences between the coper and non-coper ACL-deficient knee subjects. In addition, the maximum jumping height was significantly higher in the copers too (p=0.008).

Discussion: While the pain, symptoms and daily activities were not different between the two groups, a higher level of the functional abilities, sports activities, quality of life and the maximum jumping height were shown in the coper ACL-deficient knee subjects when compared to the non-copers. A deliberate evaluation of the functional abilities in ACL-deficient knee subjects might play a key role in distinguishing the coper and non-coper ACL-deficient knee subjects.

Keywords: Anterior cruciate ligament deficient knee, Copers, Non-copers, Questionnaire, Vertical Jump

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Introduction

Anterior cruciate ligament (ACL) injury is the most common knee ligament injuries during sports activities with a rate of 30 among 100,000 people in the USA (1). Almost 70% of these injuries are classified as non-contact types, especially during jumping and/or cutting activities(2). Moreover, almost 70% of such injuries are in a complete form and 86% of them are accompanied with meniscal tears (3). The ACL is not only considered as a mechanical constraint for knee movements, but also is known as a source of proprioception and plays an essential role in dynamic neuromuscular control of the knee (4). The primary mechanical

role of the ACL is restricting anterior movement of the tibia relative to the femur as well as controlling excessive axial rotation. Injuries to this ligament may result in functional limitation, low quality of life, and in some cases reduction in sports performance compared to pre-injury level (3, 4). ACL injury is known as the most common sporting injuries among athletes in the world, but unfortunately no published data is available in this regard in Iran (5).

Based on the potential return of the ACL-D knee subjects to their pre-injury level, these subjects may be divided into the copers and non-copers (6-8). The Persian version of the International Knee

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Documentation Committee (IKDC) and Knee Injury and Osteoarthritis Outcome Score (KOOS) questionnaires have already shown to be valid in Iranian subjects with various knee injuries (9, 10). Since the questionnaire included many subscales to test different functional activities, they might be used in differentiating the copers and non-coper ACL-D knee subjects from each others. To the best knowledge of the authors, there is no research studying the level of disabilities between the copers and non-coper Iranian athletes with ACL tear via using the Persian version of the IKDC and KOOS Questionnaires. Therefore, the aim of the present study was to compare the functional outcomes between the copers and non-coper ACL-deficient knee groups of Iranian athletes with ACL-deficient knees.

Methods

Thirty-four professional athletes with complete unilateral isolated ACL tear (ages 20-29 yrs.), with times past injury between 6-12 months after their injuries, participated in the study. They had no history of vision problems, vertigo, limb numbness, fractures, or surgeries. In addition, they had not used any anti-inflammatory, pain killer or sedative drugs at least one week prior to testing. Informed consent was obtained from all subjects before participation. Based on the report of giving way and feeling of instability in the injured knee during the past 3 months, subjects were divided into two groups of copers (n=17) and non-copers (n=17) (11).

The study was conducted in two phases. The first phase was a methodological un-experimental study in order to evaluate the reliability Persian version of International Knee Documentation Committee (IKDC) and Knee injury and Osteoarthritis Outcome Score (KOOS). In the second phase, a non-experimental comparative study was performed to analyze the differences in maximum vertical jump height and functional outcomes (IKDC, KOOS, Tegner scores) between copers and non-coper ACL-deficient subjects. Tegner Questionnaire is a measure of activity level based on the sports type and activity frequency. For each activity, a 10-point scale is scored. The individual scores are summated to obtain a total score. The activity levels of 5-10 are used for those, in recreational or sports activities. The scores of 3 or less are specified for subjects who cannot participate in sports or recreational activities, running, or light

sports activities. People with scores of 7 or higher may take part in light and high-level sports competitions (12).

The IKDC Questionnaire is one of the simplest tools for assessing function in patients with ACL injuries. The questionnaire consists of 3 sections and 10 questions including: a) the signs and symptom subscale with 7 questions; b) the sports subscale with 2 questions; and 3) the function subscale with 1 question. The higher scores show milder disabilities(9). The Persian version of the IKDC has been shown to be reliable and valid for Iranian people with various knee injuries (13). The KOOS is one of the most popular instruments for the assessment of functional outcomes in subjects with ligamentous, meniscal and degenerative knee problems. The questionnaire is composed of 5 subscales with 42 questions including: 1) the symptoms and stiffness subscale with 7 questions; 2) the Pain subscale with 9 questions; 3) the activities of daily living subscale with 17 questions; 4) the sports and recreation subscale with 5 questions; and 5) the quality of life subscale with 4 questions(10). KOOS has been cross-culturally adapted and translated into Persian. Its Persian version has been reported to have adequate reliability for use in Iranian people with ACL injury and after reconstruction surgery (13). In order to measure maximum vertical jump height, a reflective marker of Vicon motion analysis system (Vicon MX, Oxford Metrics, UK) was placed on subjects' right greater trochanter. Then the subject was asked to stand up while he/she had his/her hands held on the sides and jump up as high as possible. By collecting the data and analyzing the marker movement in the space while standing, the amount of jump height was recorded for each subject. The test was repeated three times for each participant and the greatest value was considered as the maximum jump height for the subject (14).

Descriptive statistics including mean, standard deviation (SD), Minimum, Maximum and variance was calculated for studied variables separately in copers and non-copers. Shapiro-Wilk tests were used to assess the distribution of variables. Intraclass correlation coefficient's (ICCs), Standard Errors of Measurement (SEMs) and Cronbach's Alpha coefficients were calculated as measures of reliability. In order to compare variables between copers and non-copers, independent t tests were used. Significant level was set at 0.05 for all statistical tests.

Results

Table (1) shows the descriptive statistics of all variables including age, BMI, KOOS scores, IKDC

scores, and Tegner scores in the two groups of copers and non-copers.

Table 1. Descriptive statistics of the variables in the two groups of copers and non-copers

Variables & Group	N	Mean	SD	Minimum	Maximum	Variance	
Age	Non- coper	17	24.41	0.96	18	29	15.75
	coper	17	25.23	0.84	18	29	12.19
BMI	Non- coper	17	24.73	0.73	19.84	29.41	9.24
	coper	17	23.57	0.62	18.79	28.73	6.66
KOOS pain subscale score	Non- coper	17	83.82	2.94	58	97	147.02
	coper	17	90.17	2.94	56	100	147.27
KOOS activities of daily living subscale score	Non- coper	17	60.17	3.11	39	82	165.02
	coper	17	63.47	1.58	50	71	42.51
KOOS symptom and stiffness subscale score	Non- coper	17	89.41	2.17	75	100	80.75
	coper	17	93.70	1.73	69	100	51.22
KOOS sports and Recreation subscale score	Non- coper	17	57.05	4.53	20	90	350.18
	coper	17	80.88	4.41	40	95	331.98
KOOS quality of life subscale score	Non- coper	17	33.58	2.74	6	50	128.50
	coper	17	48.64	5.21	13	75	462.99
IKDC Total Score (out of 100)	Non- coper	17	64.50	3.12	43.68	82.76	165.79
	coper	17	83.97	2.43	56.32	93.10	101.15
Tegner Score	Non- coper	17	5	0.3	3	7	1.62
	coper	17	7.24	0.32	5	9	1.81

Table (2) shows the values of ICC, SEM and Cronbach's Alpha coefficient for IKDC and KOOS subscales scores during test-retest. The significance levels of Shapiro-Wilk tests for these

variables are also included in table (2). The results indicate adequate test-retest reliability and normal distribution of all variables.

Table 2. ICCs, SEMs, Cronbach's Alpha Coefficient, and Shapiro-Wilk significant level for IKDC and KOOS scores.

Variable	ICC	SEM	Chronbach Alpha	Shapiro-Wilk Significance Level
IKDC total score (out of 100)	0.92	0.33	0.90	0.45
KOOS pain subscale score	0.90	0.28	0.89	0.27
KOOS symptom and stiffness subscale score	0.91	0.31	0.90	0.85
KOOS activities of daily living subscale score	0.81	0.41	0.86	0.37
KOOS sports and Recreation subscale score	0.98	0.31	0.88	0.55
KOOS quality of life subscale score	0.94	0.31	0.72	0.64

According to the results of independent t-test in table (3) age and BMI were not significantly different between copers and non-copers.

However, the Maximus vertical jump height was significantly higher in copers (p=0.008)

Table 3. Comparison of age and BMI index as well as the highest jump in the two groups of copers and non-copers under study

Variable	Mean ± SD		d.f	Minimum	Maximum	Probability	Confidence Limit	
	Non- coper	coper					Upper Limit	Lower Limit
Age	24.41± 3.97	25.24 ±3.49	32	18	29	0.574	27.03	23.44
BMI Index	24.74 ±/3.04	23.57 ±2.58	32	19	29	0.252	24.62	23.18
Maximum Jumping Height	0.4 ±0.05 m	0.47± 0.08 m	32	0.31	0.67	0.008	0.46	0.41

The result of independent t-tests for the scores of IKDC, KOOS and Tegner between the two groups of copers and non-copers are presented in table (4). IKDC score, as well as, the scores of sports recreation, and quality of life subscales of KOOS

were significantly higher in copers, with p-values of <0.001, 0.001 and 0.016, respectively. There were no significant differences for other KOOS subscales and Tegner scores between the two groups.

Table 4. Comparison of IKDC, KOOS and Tegner scores in copers and non-coper subjects.

Variable	Mean and SD		t	d.f	P value	Confidence Limits	
	Non-Copers	Copers				Upper Limit	Lower Limit
*IKDC	64.50 ±12.87	83.9±10.05	4.914	32	<0.001	27.54	11.40
KOOS pain subscale score	83.82 ±12.12	90.18±12.13	1.527	32	0.137	14.82	-2.12
KOOS symptom and stiffness subscale score	60.18±12.84	63.47 ±/6.52	0.943	32	0.353	10.41	-3.82
KOOS activities of daily living subscale score	89.41 ±8.98	93.71 ±7.15	1.541	32	0.133	9.97	-1.38
* KOOS sports and Recreation subscale score	57.06±18.71	80.88 ±18.22	3.761	32	0.001	36.72	10.92
* KOOS quality of life	33.59 ±11.13	48.65 ±21.51	2.533	32	0.016	27.07	3.04
Tegner	±5 / 1.27	7.24 ±/1.34	4.968	32	0.566	3.15	1.31

* indicates significant difference

Discussion

Patient-oriented instruments for assessing outcome of knee problems have been advised as their potential for comparing outcomes such as clinical signs and symptoms, functional activity level, disability, satisfaction and quality of life. In the present study, these outcomes were compared between copers and non-coper subjects with ACL tears with the use of IKDC, KOOS and Tegner Questionnaires.

The findings of the present study have shown that there were significant differences between the copers and non-coper ACL- deficient Knee subjects during performing sports level, daily living activities, and the quality of life. Van Meer, et al (2013) have reported that patients following ACL injury complain about the instability of their knees in activities of daily living and sports and low quality of life (15). Moreover, they noted that the KOOS better shows the long term impacts of the injury, while the IKDC better depicts the short-term complications as well as the long-term ones of these patients. According to van Meer (2013), the KOOS subscales of symptoms and stiffness, pain and activities of daily living were not significantly different between the two groups of copers and non-copers. It may be because their subjects did not have enough time to see the long-term effects of their knee injury. However, they did not have such a problem with the use of IKDC(15). Moksnes, et al (2008) recruited 125

patients with ACL injury (79 non-copers and 46 copers) in a cohort study (16). After a year, 23 patients were excluded from the study for various reasons. Of the 102 remaining patients, 52 patients were being treated conservatively by the decision of their surgeons. The treatments included strength and neuromuscular exercises. Other 50 subjects had undergone surgery. In the preliminary assessment, the IKDC scores for talented copers and non-copers were 78.5 (±8.2), 61.9 (±14), respectively. At the second assessment, after one year for those who had undergone surgery, the IKDC scores for real copers and non-copers were 92 (±3)and 84 (±4), respectively. Therefore, IKDC had the potential for evaluating the amount of long-term effects of treatment on patients' condition. Consistent with these reports, the talented copers and non-copers in the present study had different IKDC and KOOS scores (16).

Our results showed higher scores in copers as compared to non-copers. The Persian versions of IKDC and KOOS have shown to be satisfactorily reliable and valid in the previous studies(9). Our results also show that they can discriminate between copers and non-coper athletes with ACL deficiency. The non-copers have fewer problems in symptoms, physical impairment, and simple low-challenging functional tasks. However, in more difficult conditions and more challenging situations, the differentiations between the two groups will be more visible.

Moreover, due to the importance of such conditions in more global outcomes such as satisfaction, and quality of life, they show more precise results in these measures. In line with the results of the present study, such outcomes may be considered to be able to differentiate between copers and non-copers. Therefore, more attention should be paid on functional outcomes such as disability in high-challenging activities, patient satisfaction and quality of life.

In general, various impairments in body structure and function, such as muscle strength and activity pattern, proprioception and joint stiffness, have been reported in patients with ACL injury. The findings of the present study suggest that these disorders may result in disability, reduction of quality of life and reduction of patient satisfaction about knee function.

Another finding of the present study was the higher height of vertical jump task in copers. This agrees with those of Rosendal et al (17). Vertical jump as a valid and reliable functional test in commonly used to evaluate the ability of athletic population during an essential task needed in a vast majority of sports activities. Rudolph et al (2000) believe that lower performance of non-coper during sports functions is due to their fear of inducing further

damage to the injured knee(18). Fear of movement has not been measured in the present study. However, the history of giving way and feeling of instability in the injured knee among our non-coper subjects, make such an explanation quite probable for our results.

In future studies, the Persian versions of IKDC and KOOS may be suggested to be used in order to evaluate and compare the effect of various treatment and rehabilitation methods for coper and noncoper subjects with ACL tears. This may provide data about the responsiveness. Also, correlation between neuromuscular and motor control parameters with the level of disability, patient satisfaction and quality of life may be assessed in further studies. Such data may be useful for evaluating the functional significance of common impairments in ACL-deficient patients.

Conclusion

The functional abilities, sports performance, quality of life, as well as, the vertical jump height were higher in coper ACL-injured athletes compared to non-copers. However, copers and non-copers were similar in their symptoms, pain and activities of daily living.

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