

Comparison of the Effectiveness of Two Management Strategies in the Pandemic COVID-19 Period in Patient Visits (Face-to-Face Visits vs. a Smartphone) in follow-up the Range of Motion of the Knee in Patients with Anterior Cruciate Ligament Reconstruction

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Abstract

Background: As the prevalence of the coronavirus increases, there is now more emphasis on reducing “face-to-face” patient visits. Therefore, the use of smartphones and their special medical applications can play an important role in following up patients. The aim of this study was to evaluate the use of smartphone in evaluating clinical outcomes and range of motion (ROM) of patients after anterior cruciate ligament reconstruction (ACLR).

Materials and Methods: From January to December 2020, 112 patients between 20 and 50 years old were randomly selected at our orthopedic sports center. All patients were visited online through smartphone by a knee fellowship surgeon in the morning (case group) and again all of them were visited online through smartphone in the evening by another knee fellowship surgeon (control group). Both visits were done at regular intervals in the 2nd, 6th, and 12th week after surgery. Patients were evaluated for function outcomes and joint ROM.

Results: The two groups were similar in terms of mean International Knee Documentation Committee score, Lysholm knee score, and Tegner Knee Score and did not show statistically significant difference ($P < 0.05$) There was no significant difference in knee ROM measurements between the two groups (face-to-face visits and online through smartphone visits) during the follow-ups ($P > 0.05$).

Conclusion: Smartphone apps are highly effective in assessing postoperative condition of knee ROM after ACLR, especially in the short time. However, this ability has been reduced in evaluating the long term. Hence, evaluation is still necessary through direct examination in the presence visit.

Keywords: Anterior cruciate ligament reconstruction, coronavirus, pandemics, range of motion, smartphone

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Submitted: 11-Apr-2021; **Revised:** 07-Jul-2021; **Accepted:** 31-Aug-2021; **Published:** 28-Nov-2022

INTRODUCTION

Coronavirus is an acute respiratory syndrome caused by SARS-CoV-2 that was first reported in Wuhan, China, in

December 2019.^[1-3] On March 11, 2020, the World Health Organization declared the disease pandemic^[4] as social

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How to cite this article: Aslani H, Bonakdar S, Gorji M, Gholipour M. Comparison of the effectiveness of two management strategies in the pandemic COVID-19 period in patient visits (face-to-face visits vs. a smartphone) in follow-up the range of motion of the knee in patients with anterior cruciate ligament reconstruction. *Adv Biomed Res* 2022;11:102.

Access this article online

Quick Response Code:



Website:
www.advbiores.net

DOI:
10.4103/abr.abr_82_21

distancing and closure of school and public offices is not limited to sick people.^[5,6]

Telecommunication portals can be a useful tool for remotely monitoring patients and advising them on how to care for them (in cases where patients are unable to stay in the hospital due to long distances or when the system does not allow face-to-face counseling such as pandemic conditions). Smartphone applications can be used as a cost-effective and convenient tool for transmitting patients' medical information to physicians, such as following up patients after orthopedic surgery.^[7]

Anterior cruciate ligament reconstruction (ACLR) with a 95% chance of success is the gold-standard treatment for anterior cruciate ligament rupture.^[8-10]

Anterior cruciate ligament tear is common between the ages of 15 and 34 years.^[11,12] In the United States surgery of active people with a high possibility of returning to preinjury activity level known as final protocol^[13,14] In orthopedic surgery, follow-up of patients is important and failure to follow can cause irreparable damage to the patient and the health system. The popularity of smartphone applications for clinical evaluation of patients is increasing among physicians, and many studies have evaluated the reliability and validity of smartphone applications for ROM measurement.^[15-17] In our surgical centers, at the same time with the outbreak of the coronavirus, an online visit system was set up and most patients were followed up in this way. The main objective of this study is to determine the accuracy of telemedicine in tracking patients who have undergone ACLR.

MATERIALS AND METHODS

This is a retrospective case-control study on 112 patients between 18 and 50 years, in an 11-month period from January to December 2020 with a definitive diagnosis of anterior cruciate ligament rupture. Study conditions were explained to all patients, and written consent was signed by all participants. Exclusion criteria included limb deformity, BMI ≥ 30 , multiple ligament injury, and incomplete electronic records. Demographic information and surgical results of patients were collected from patients "electronic records and patients" operating room record. An ethical approval was obtained from Ethic Committee of Shahid Beheshti University of Medical Sciences, Tehran, Iran. The patients were underwent reconstruction with hamstring autograft by single knee fellowship surgeon. The rehabilitation protocol was the same for all patients before and after surgery. After the operation, they were visited at regular intervals in the 2nd, 6th, and 12th week by surgeon separately and on a working day (morning and evening). In the morning shift, patients (case group) were visited online using a smartphone app (WhatsApp, etc.)^[18] and patients were asked to take a photograph of the knee in flexion and extension mode with the help of a companion at the end of each visit and send it to the doctor. In the evening shift, the patient was visited directly

by the physician and the amount of flexion and extension was measured. In online visits, the angle of flexion and extension is drawn from the photograph using two hypothetical lines, the first line on the horizontal plane tangent to the upper border of the thigh and the second line tangent to the upper border of the patient's leg [Figure 1a and b]. The angles drawn are measured by a universal goniometer. At the end of the study, the amount of flexion and extension was compared between the two groups of visits (face-to-face and online). Demographic and surgical information were extracted from patients' electronic medical records. Patients' functional outcome was assessed once through an online visit and once through a face-to-face visit. For all patients, the International Knee Documentation Committee (IKDC questionnaire),^[19] Lysholm Knee Scoring (LKS) scale, and the Tegner Activity Scale^[20] were completed 3 months after surgery. The results of patients' performance were evaluated once through online visits and once through face-to-face visits. The results were presented as mean \pm standard deviation for quantitative variables and were summarized by absolute frequencies and percentages for categorical variables. Normality of data was analyzed using the Kolmogorov-Smirnoff test. Categorical variables were compared using Chi-square test. Quantitative variables were also compared with *t*-test or Mann-Whitney *U*-test. For the statistical analysis, the statistical software SPSS version 16.0 for windows (SPSS Inc., Chicago, IL, USA) was used. *P* values of 0.05 or less were considered statistically significant.

RESULTS

In this study, 112 patients were evaluated. As shown in Table 1, the study included 112 patients, including 57.2% men and 42.8% women female with an average age of 32.33 ± 8.55 years. Mean operation time was 60.26 ± 9.55 min. The mechanism of the initial injury was sport in 67.9% of patients and nonsport in 32.1% of patients. The postoperative assessment of knee functional status using the three-pointed assessment scores [Table 2]. The two groups were similar in terms of mean IKDC score, Lysholm Score, and Tegner Score, and the difference was not statistically significant ($P < 0.05$). As indicated in Table 3, there was no difference in flexion and extension laxity ranges of knee motion degrees between the



Figure 1: (a) Six week after right ACLR follow-up with smartphone application, (b) 6 week after right ACLR follow-up with clinical visit. ACLR: Anterior cruciate ligament reconstruction

case and control groups at different times of following-up. In this regard, high similarity was observed between mobility degrees assessed with online visits by the smartphone and during the clinical in person visits at the 1st week.

DISCUSSION

Recovery after ACLR surgery, especially the range of motion of the joint, is very important to return to preoperative activity.^[21] At present, with the outbreak of the COVID-19 pandemic and the restrictions imposed by the government on traffic and patients' concerns about the possibility of contracting the disease, the number of patients seeking follow-up after surgery has decreased.^[22] At present, one of the most important measures after surgery ACLR prevents the knee from reducing range of motion after surgery. Therefore, patients need regular follow-up and rehabilitation exercises.^[21] The use of mobile

apps not only provides the ability to evaluate the patient's diagnostic and treatment follow-up remotely. In addition to increasing patient satisfaction, in addition to increasing patient satisfaction, the cost of patient visits is also reduced by frequent visits to clinics.

However, there are still many doubts about the accuracy of the images provided by the patient using these programs. This is especially true of limited range of motion in the joints. We evaluated the importance of smartphone. In this regard, all patients were visited twice online through smartphone (on line visit) and in person.

In this study there was a significant relationship between patients' face-to-face visits and smart visits, especially in assessing knee flexion. In this regard, in all three follow-up periods, the use of a smartphone can be a suitable and high-level option to assess the range of motion of the knee in flexion mode. The companion smartphone has been approved in the previous studies to evaluate knee joint improvement after surgery, instead of frequent visits to visit. In the study of Bahadori *et al.*,^[23] the quality and feasibility of 15 applications were evaluated and their ability to be particularly operational in assessing knee joint was confirmed. In the study of Castle *et al.*,^[24] the camera was a smartphone case used to assess knee flexion, and simultaneous physical examination was done by the physician using a goniometer. The correlation between the smartphone applications with standard goniometer was evaluated for flexion and knee extension, as 94% and 90% respectively. Furthermore, the reliability of the smartphone with standard goniometer was estimated to be 0.89 and 0.89, respectively, for the evaluation of flexion and knee extension. In the study of Ockendon and Gilbert,^[25] The correlation between smartphone measurement and standard goniometer measure for Lafayette operating system was 0.952, and for the iPhone operating system, it was 0.982, which was consistent with our study, In the study of Dietz *et al.*,^[26] there was a high correlation between two methods of measurement with standard goniometer of the standard arm and also using the goniometer based on the smartphone operating system (ICC = 0.49). In the study of Hancock *et al.*,^[27] there was a high correlation between physical methods and the method of using smartphones (correlation more than 0.98). The difference in angle between the two methods of physical evaluation and smartphone was about 6°. In the study of Hancock *et al.*,^[28] A literature review involving 12 studies demonstrated that smartphone applications are reliable enough to be used in research and clinical practice, but further validation studies are needed. In the study of Kose *et al.*,^[29] telephone interview is a reliable mode of administration for LKS. Researchers can design studies using telephone interview as a mode of admin for LKS or use mixed-mode designs as both modes of administration end up with similar results. The study of Abdel Messih *et al.*^[30] compared telephone and postal methods of administration of the Oxford Knee Score in patients undergoing total knee arthroplasty. They concluded that telephone and mail administration produced equivalent survey responses at a group

Table 1: General demographic and surgical information of patients (n=112)

Variable	Results
Sex, n (%)	
Male	64 (57.2)
Female	48 (42.8)
Mean age, year (means±SD)	32.33±8.55
Side of involvement, n (%)	
Left	47 (42)
Right	53 (58)
Mechanism of injury, n (%)	
Sportive	76 (67.9)
Nonsportive	36 (32.1)
Mean operation time (means±SD)	60.26±9.55

SD: Standard deviation

Table 2: Functional outcome between two groups

Variable	Mean±SD		P
	Case group	Control group	
IKDC score	83.21±4.81	82.94±3.75	0.060
Lysholm score	88.80±5.63	87.16±5.30	0.296
Tegner score	58.48±4.83	58.61±4.81	0.850

SD: Standard deviation, IKDC: Knee documentation committee

Table 3: Comparing range of motion degrees after surgery between two groups

variable	Case group	Control group	P
2 weeks after surgery			
Flexion	86.99±4.76	87.67±4.08	0.058
Extension laxity	3.96±1.38	3.09±1.46	0.577
6 weeks after surgery			
Flexion	129.16±5.66	130.34±5.11	0.171
Extension laxity	1.46±0.8	1.59±0.86	0.708
12 weeks after surgery			
Flexion	137.90±4.34	138.85±3.87	0.179
Extension laxity	0.589±0.578	0.70±0.609	0.825

level. However, they advocate using telephone interview over postal administration. In the study of Kim *et al.*,^[31] using a smartphone application could be a useful method for measuring knee rotation angle, which could be applicable with ease in patients with rotatory instability. In the study of Jenny,^[32] therefore, there is a weak correlation between face-to-face and smartphone methods for examining knee extensions. This may be due to the poor quality of imaging by patients and the patient's lack of cooperation using smartphones. Second, due to minor changes in the knee joint extension, it was not possible to assess these minor changes without a face-to-face visit and it is only based on images from the smartphone. Therefore, it is recommended to use smartphone technology to evaluate changes in knee flexion. However, the use of this technology in evaluating, confirming, or rejecting the extent of laxity of extensions is not recommended, or at least the use of more accurate methods along with better patient education is absolutely necessary to use these smart programs. The smartphone application used may be considered as precise and accurate. Using this technology to assess the knee range of motion allows an accurate scoring of this item, which is significant in all scoring systems. The accuracy may be higher than other conventional measurement techniques.

CONCLUSION

Smartphone applications are very effective in examining the range of motion of the knee in the short period after the reconstruction of the anterior cruciate ligament. However, face-to-face examination is still an important evaluation criterion for these patients.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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