

# Comparison of Periodic in-Person and Remote Visits via Smartphone Applications during COVID-19 Pandemic in Clinical Follow-up of Range of Motion in Patients with Distal Radius Fracture

Amir Sabbaghzadeh<sup>1</sup>, Sona Bonakdar<sup>1,2</sup>, Maryam Khoshkholghsima<sup>1</sup>, Melina Moshirpour<sup>1</sup>, Mona Gorji<sup>3</sup>, Morteza Gholipour<sup>1</sup>

<sup>1</sup>Orthopedic Surgery Department, Shohada Tajrish Hospital, Shahid Beheshti University of Medical Sciences, Tehran, Iran, <sup>2</sup>Department of Foreign Languages, Urmia University, Urmia, Iran, <sup>3</sup>Skin Research Center, Shahid Beheshti University of Medical Sciences, Tehran, Iran

## Abstract

**Background:** Wrist function has a significant impact on quality of life, which is why restoring normal wrist movement after surgery is so important. Due to the COVID-19 pandemic, and the restrictions imposed on “face-to-face” visits, using smartphones has become more important in tracking patients. The main purpose of this study was to determine the accuracy of telemedicine in following up patients who had undergone distal radius fracture operation.

**Materials and Methods:** From February to October 2020, 126 patients between 20 and 60 years old were randomly selected at our orthopedic trauma center. All patients were visited in person by an orthopedic surgeon in the morning (control group) and again all of them were visited online via smartphone in the evening by another orthopedic surgeon (case group). Both visits were done at regular intervals in the 2<sup>nd</sup>, 6<sup>th</sup>, and 12<sup>th</sup> weeks after surgery. Patients were evaluated for extremity function outcomes and joint range of motion.

**Results:** The two groups were similar in terms of mean Patient-Rated Wrist Evaluation score and Disabilities of the Arm, Shoulder, and Hand score and did not show a statistically significant difference ( $P < 0.05$ ). There was no significant difference in wrist range of motion measurements between the two groups (in-person visits and smartphone visits) during the follow-ups ( $P > 0.05$ ).

**Conclusion:** Changes in wrist range of motion after surgery can be assessed with high accuracy using smartphone applications and this method can be considered as a proper alternative to frequent in-person visits to evaluate postsurgical wrist condition.

**Keywords:** COVID-19, pandemics, radius fractures, range of motion, smartphone

**Address for correspondence:** Dr. Morteza Gholipour, Shahid Beheshti University of Medical Sciences, Tehran, Iran.

E-mail: moortho1990@yahoo.com

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## INTRODUCTION

A new strain of coronavirus with the potential to cause fatal pneumonia was identified in Wuhan, China, and spread rapidly to other parts of the world in late 2019.<sup>[1]</sup> The World Health Organization declared this coronavirus infection as a pandemic on March 11, 2020.<sup>[2]</sup> The first case of this disease in Iran was reported in February 2020, in Qom.<sup>[3]</sup> Due to the

lack of prophylactic vaccines and therapeutic drugs, public health measures such as social isolation, quarantine, and isolation of patients were the only logical ways to prevent the spread of the disease.<sup>[4]</sup> With the emergence of the first case in Iran, serious measures were taken to reduce the prevalence

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of the disease. These measures included shutting down public places and schools, distance education, and travel ban. Elective surgeries were limited and only trauma patients were admitted to hospitals. Patients were mostly visited through online platforms for follow-ups.

Telemedicine is the exchange of medical information from one location to another using electronic communication to provide clinical health care remotely.<sup>[5]</sup> Using smartphones by health-care professionals for medical and rehabilitation purposes has been on the rise thanks to the growing number of applications that can transform a cellular phone into a medical device.<sup>[6,7]</sup> Furthermore, in recent years, telemedicine has been adopted in several domains of surgical care, including preoperative and postoperative care.<sup>[8-10]</sup>

Distal radius fracture is the most common fracture in the general population, accounting for approximately 10%–18% of adult fractures.<sup>[11]</sup> Wrist function plays an important role in an individual's quality of life. It is very important for the surgeon to maintain wrist range of motion and improve it after surgery. In our trauma center, as a result of coronavirus outbreak and restrictions to reduce the disease transmission, in-person visits decreased and the tendency to use online visits increased. The main objective of this study is to determine the accuracy of telemedicine in tracking patients who have undergone wrist surgery.

## MATERIALS AND METHODS

### Study design

This study is a retrospective casecontrol study, which was performed after obtaining approval from the Shahid Beheshti University of Medical Sciences Ethics Committee, in a period of 9 months between February and October 2020. One hundred and twenty-six patients in the age group between 20 and 60 years old were randomly selected from patients with distal radius fractures who underwent open reduction and internal fixation with locking volar plate. Study conditions were explained to all patients, and written consent was signed by all members. All patients had a normal physical and exercise program at home and were visited postoperatively at regular intervals in the 2<sup>nd</sup>, 6<sup>th</sup>, and 12<sup>th</sup> weeks by two orthopedic surgeons separately, on a working day (morning and evening). In the morning, the patients were visited in person, and flexion, extension, ulnar deviation, and radial deviation were measured directly by the orthopedic surgeon (control group). In the evening, the visits were delivered online via a smartphone application (case group). Patients were asked to take pictures with their healthy hand using a smartphone application (WhatsApp, etc.).<sup>[12]</sup> While the operated hand was on the table in flexion, extension, ulnar deviation, and radial deviation. Then, the patients sent the pictures to the physician and visual physical examination was performed by the physician. In remote visits, the angle of flexion and extension is drawn as two hypothetical lines: the first line is in the sagittal

plane in the lateral border of the radius and the second line is tangent to the dorsal surface of the metacarpal [Figure 1a]. The ulnar deviation and radial deviation are plotted as two hypothetical lines: the first line is in the coronal plane in the lateral radius border and the second line is in the metacarpal border [Figure 1b]. The drawn angles are measured by a universal goniometer. The study endpoint was to determine and compare the wrist flexion, extension, ulnar deviation, and radial deviation, between the two groups of visits (in-person and telemedicine). Demographic and surgical information was extracted from patients' electronic medical records. Patients' functional outcome was assessed once through a smartphone visit and once through a face-to-face visit. For all patients, the Patient-Rated Wrist Evaluation (PRWE) questionnaire and Disabilities of the Arm, Shoulder, and Hand (DASH) score were completed 3 months after surgery.<sup>[13]</sup>

### Data analysis

Statistical analyses were done using SPSS software version 16 (SPSS, Inc., Chicago, IL, USA) with a significance level of 5% and a 95% confidence interval. The results were presented as mean in standard deviation (SD) for quantitative variables and were summarized by absolute frequencies and percentages for categorical variables. Descriptive data were reported as mean  $\pm$  SD. Chi-square test was used for qualitative variables, and Student's *t*-test was used to compare wrist range of motion between the groups.

## RESULTS

In this study, 126 patients were evaluated. As shown in Table 1, the group of study ( $n = 126$ ) included 51.6% of males and 48.4% of females with an average age of  $41.03 \pm 9.69$  years. The average time to operation was  $54.06 \pm 10.93$  min. The mechanism of the initial injury was fall onto an outstretched hand in 61.1% of patients, car accident in 16.7% of patients, and motor accident in 22.2% of patients. Type 2 was the most common form of fracture according to the Fernandez classification. The most common postoperative complication was complex regional pain syndrome. The two groups were similar in terms of mean PRWE score and DASH score, and the difference was not statistically significant [Table 2]. As shown in Table 3, there was no difference in wrist range of motion between the case and control groups at different follow-up visits ( $P > 0.05$ ). In this regard, high similarity was observed



**Figure 1:** (a and b) Photo of a patient with distal radius fracture 6 weeks after surgery

**Table 1: General demographic and surgical information of patients (n=126)**

Variable	Results (%)
Mean age (years), mean±SD	41.03±9.69
Sex	
Male	51.6
Female	48.4
Side of involvement	
Left	34.1
Right	65.9
Distal radius fracture type (Fernandez)	
Type 1	4
Type 2	27
Type 3	34.1
Type 4	20.6
Type 5	14.3
Mechanism of injury	
Car accident	16.7
FOOSH	61.1
Motor accident	22.2
Complication	
CRPS	10.3
Skin breakdown	7.1
Wound discharge	7.9
Operation time (min), mean±SD	54.06±10.93

SD: Standard deviation, CRPS: Complex regional pain syndrome, FOOSH: Fall onto an outstretched hand

**Table 2: Functional outcome between two groups**

Variable	Smartphone visit	Face-to-face visit	P
PRWE score (mean±SD)	14.35±2.16	13.81±2.00	0.325
DASH score (mean±SD)	16.71±4.95	16.31±3.66	0.068

SD: Standard deviation, PRWE: Patient-Rated Wrist Evaluation, DASH: Disabilities of the Arm, Shoulder, and Hand

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

Variable	Smartphone visit	Face-to-face visit	P
2 weeks after surgery			
Flexion	15.18±3.56	16.06±2.88	0.190
Extension	11.12±2.54	10.99±2.27	0.240
Radial deviation	9.74±2.13	9.39±2.10	0.585
Ulnar deviation	9.29±2.39	9.56±2.38	0.913
6 weeks after surgery			
Flexion	42.79±8.07	42.39±6.52	0.066
Extension	38.89±6.46	38.36±5.82	0.083
Radial deviation	15.64±2.54	16.30±2.41	0.340
Ulnar deviation	20.89±2.79	20.67±2.51	0.100
12 weeks after surgery			
Flexion	60.10±7.88	62.66±7.22	0.179
Extension	63.12±8.25	62.46±7.61	0.272
Radial deviation	21.02±2.75	21.43±2.97	0.365
Ulnar deviation	32.37±2.85	31.38±2.94	0.802

between mobility degrees assessed by the smartphones and during the clinical in-person visits.

## DISCUSSION

Patients' undergone orthopedic surgeries require frequent postoperative visits to an orthopedic surgeon for evaluation of short- and long-term postoperative outcomes, especially in terms of assessing changes in the range of motion in the operated site. Currently, due to the COVID-19 pandemic and patients' concerns about the possibility of infection by coronavirus, as well as the restrictions imposed by the government, the patients' compliance to follow the treatment plan has decreased. In this regard, methods such as photography, video recording, and using smartphone applications are used as alternative ways for patient evaluation. In this study, the correlation between the standard assessment method (periodic in-person visits) and remote methods such as online visits using a smartphone application was investigated. In this regard, it was found that using smartphones is a good and accurate alternative to in-person visits in the postoperative evaluation, including the amount of wrist movements. It is possible to prevent repeated face-to-face visits by asking the patient to send pictures of wrist movements to the physician; therefore, assessing wrist range of motion after surgery can be done remotely. In this way, changes in the wrist range of motion can be evaluated with high accuracy and without the need for face-to-face consultation. In our study, there was no difference between the angle of wrist movements measured in a face-to-face visit and a remote visit with a smartphone. In other words, patients with distal radius fractures do not need to be visited in person for wrist movement's evaluation, and the physician decides whether or not to continue rehabilitation based on the patient's photo. Considering the public access to smartphones, patient follow-ups can be done through video calls and angles of limb movement could be measured accurately based on the photos taken by the patient. As a result, remote visits could be a proper alternative for in-person visits in postoperative follow-ups.

Other studies have shown similar results. In a study by Wagner *et al.*,<sup>[14]</sup> there was a strong correlation between goniometric measurements and photos taken by a mobile camera. In another study by Matera *et al.*,<sup>[15]</sup> patient satisfaction was obtained in all stages. Comparing photos taken with a mobile camera with the measurements taken during the standard assessment showed an accurate assessment of wrist range of motion in remote visits. In a study by Trehan *et al.*,<sup>[16]</sup> it was possible to assess the range and angles of the wrist in 95% of the cases. In a study by Keijsers *et al.*,<sup>[17]</sup> two methods including photography and video recording showed a high validity in evaluating elbow movements, but the performance of the images taken using the mobile app was modest. According to a study by Meislin *et al.*<sup>[18]</sup> in 2016, measuring elbow range of motion using digital smartphone photography was reliable. Participants were able to take accurate photographs, and measurements based

on these photographs did not show any statistical difference with those taken by surgeons or goniometric measurements. Finally, as illustrated by Sathiyakumar *et al.*<sup>[19]</sup> in 2015, there was no significant difference in patients' satisfaction between the remote and in-person visits. Patients in the telemedicine group did not need to move their appointments compared to the control group. The telemedicine patient group spent less time on appointments. Ultimately, it can be concluded that telemedicine can be a good alternative to in-person visits, because the same care is taken and patient satisfaction will be achieved with less timing.

## CONCLUSION

As a final conclusion, changes in wrist range of motion after surgery can be assessed with high accuracy using smartphone applications and this method can be considered as a proper alternative to frequent in-person visits to evaluate postsurgical wrist condition.

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### Conflicts of interest

There are no conflicts of interest.

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