The utility of mobile phone based patient reported outcome measures in patients with acetabular fracture fixation

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Background
These remote modes of follow-up have been demonstrated to be safe by studies, and patients are equally satisfied with them as they are with in-person follow-up care. The objective of this trial was to assess the feasibility of a remote patient monitoring system that utilizes mobile phone calls in patients who have undergone surgery and have a fractured acetabulum that is equal to or older than 18 years. The system was evaluated in terms of the frequency of data interruptions and patient acceptance.

Methods
This case series study was carried out on patients aged greater than 18 years old, both sexes, who had surgery for an acetabular fracture at 3, 6, and 12 months by using a mobile phone call by (Sf-36) scoring system. All patients were subjected to mobile and questionnaire (Arabic validated form of SF-36 scoring system, first call; introduced myself, at the first call verbal consent obtained from the patient, the regimen, all red flags (severe pain, discharge, and limitation of movement), and duration of the trail were explained to the patients, 2 numbers at least obtained from the patients, and times of next calls informed to the patients.

Results
From 3 months to 6 and 12 months, there was a statistically significant increase in scores and improvement in physical functioning and role limitations as a result of physical health, energy, and fatigue. At 6 and 12 months, there was a statistically significant increase in scores and improvement in role limitations due to emotional well-being, emotional health, pain, general health, social functioning, and health change compared with 3 months (P<0.001).

Conclusions
Our research indicates that the functional outcomes of patients with acetabular fractures can be enhanced using a remote patient monitoring system that employs a mobile phone call program. Over 1 year, patients observed substantial enhancements in their emotional well-being, pain management, and physical function.

Keywords:
acetabular fractures, mobile phone based, patient-reported outcome measures

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Introduction

Acetabular fractures are articular fractures that affect the hip joint and require anatomical reduction and a rigorous long-term follow-up following fixation [1,2]. An excessively high percentage of patients experience missed follow-up appointments [3].

Except for quality of life and patient-reported functional outcomes, the radiographic outcome of acetabular fractures was the primary focus of all other studies in the past [4].

Mobile phone-based patient-reported outcome measures (PROMs) offer a transformative approach to managing patients with acetabular fractures. By leveraging mobile technology, these tools enable continuous, real-time monitoring of patient recovery, capturing a wide range of data that extends beyond physical symptoms to include mental health and patient satisfaction. This integration of technology into patient care not only enhances the convenience and accessibility of follow-up but also empowers healthcare providers to deliver more personalized and responsive care. Despite challenges such as ensuring data security and addressing the digital divide, the benefits of mobile PROMs are clear. They have the potential to significantly improve recovery outcomes, provide

valuable insights for clinical research, and ultimately, elevate the standard of care for patients recovering from acetabular fractures [5,6].

The utilization of PROMs is increasing and has the potential to influence treatment modifications [4]. Before this, this was achieved through office assessments and surveys with variable follow-up; however, this approach is inadequate for the collection of comprehensive and continuous data. [7,8].

Previous reports indicate that patients are equally satisfied with these remote modes of follow-up care as they are with in-person follow-up care, and they are safe [9,10].

There is insufficient data in the literature about the viability of a mobile phone call-based remote patient monitoring (RPM) system to determine the outcome of patients with acetabulum fractures who have undergone surgical fracture fixation. The primary outcome of this study was to measure the percentage of missed mobile-based follow-up calls at 3, 6, and 12 months postoperatively. This was accomplished by utilizing the Arabic-validated version of the 36-item short-form health survey (SF-36) to assess the PROMS following surgery for a fracture of the acetabulum. The secondary outcome was to assess the quality of life.

Patients and methods

This case series study was carried out on 37 patients aged greater than 18 years old of both sexes, who had surgery for an acetabular fracture during the period from December 2021 to March 2022.

We evaluated the PROMS after fracture acetabulum fixation surgery using mobile phone calls to follow-up at 3, 6, and 12 months using mobile phone call by (Sf-36) scoring system. The frequency of data interruptions and patient acceptance were used to evaluate the RPM system.

The study was done after approval from the Ethical Committee of the authors' institution.

Informed verbal consent was obtained from the patient or relatives of the patients during a meeting with the orthopedic surgeon, before discharging the patient from the hospital. The whole process was explained, and all red flags (severe pain, discharge, and limitation of movement) were explained to the patient. We informed the patients about the duration of the study, and at least two mobile phone numbers were obtained from each patient.

Exclusion criteria were patients younger than 18 years old and comatose patients.

All patients were subjected to mobile phone calls and questionnaires (Arabic validated form of SF-36 scoring system). In the first call between the surgeon and the patient 3 months postoperatively; the surgeon introduced himself, verbal consent was obtained from the patient, the whole process was explained again, to the patient, and times of next calls were informed to the patient. We did not face any difficulties during the call with the patient's response.

We used the Arabic validated form of (SF-36) for follow up of the patients. We evaluated the PROMS after surgery for fixation of the acetabular fracture using mobile phone calls to follow-up including patients at 3, 6, and 12 months postoperatively. We measured the scores of SF-36 of each patient at every call. We reported the missed follow-up calls with patients from the study.

Statistical analysis

SPSS v28 (IBM, Armonk, NY, USA) was employed to conduct the statistical analysis. The normality of the data distribution was assessed using the Shapiro–Wilks test and histograms. The quantitative parametric data were analyzed using an unpaired student *t*-test and presented as the mean and standard deviation (SD). The Mann–Whitney-test was employed to analyses quantitative nonparametric data, which were presented as the median and interquartile range (IQR). Qualitative variables were analyzed using the χ^2 test and the *Z*-test for percentages when appropriate. They were presented as frequency and percentage (%). Mixed-design ANOVA to analyze the data obtained from three distinct groups who were administered a questionnaire at three separate intervals. Friedman test was conducted to evaluate the differences in questionnaire scores across three time points for three different groups. Statistical significance was defined as a two-tailed *P* value that was less than 0.05.

Results

Table 1 revealed that there were 37 patients; primary education level was 10 cases only 4 (40%) completed the study, preparatory school education level was 8 cases 5 (62.5%) completed the study, secondary school education level was 15 cases 13 (87%) completed the study, bachelor education level were 3 cases all of them completed the study (100%), and Master's degree education level was 1 case and completed the study (100%). Seven (18.9%) cases were lost to follow-up due to different reasons: 5 (13.5%) cases changed

Table 1 Education level and their responses to mobile phone calls (including patients lost from the start)

Education level	Number (*n*=37)	Lost from the start (*n*=7)	Lost during the study (*n*=4)	Completed study (*n*=26) [*n* (%)]
Primary school	10	4	2	4 (40)
Preparatory school	8	2	1	5 (62.5)
Secondary school	15	1	1	13 (87)
Bachelor	3	–	–	3 (100)
Master's degree	1	–	–	1 (100)

their mobile phone numbers or gave wrong data from the start, 2 (5.4%) cases died within the duration of the study. Thirty cases were included for the analysis of SF-36 score in this study. The mean age of the patients was 35.11±11.05 years, (range from 18 to 65 years. The male-to-female ratio was 2.75: 1, with 22 (73.3%) males and eight (26.7%) females. Twenty-six (87%) patients responded to all mobile phone calls and completed the study.

Using the SF-36, a statistically significant rise in physical functioning and improvement of role limitations was observed from three months to six and twelve months, as evidenced by the findings of physical health, energy, and fatigue. In comparison to the 3 months, there was a statistically significant rise of scores of role limitations due to emotional health, emotional well-being, social functioning, pain, general health, and health change at 6 and 12 months (P<0.001) (Table 2).

One (3.3%) case needed Total hip arthroplasty. It was a male patient 30 years old who had fractured the anterior wall of the right acetabulum.

Discussion

Acetabular fractures are particularly difficult to treat surgically. Functional impairment has been linked to inaccurate articular reductions, which may ultimately necessitate conversion to total hip arthroplasty. The Merle d'Aubigné system has been the traditional method for evaluating the functional outcome of acetabular fracture fixation. This joint specific score is widely acknowledged to have four limitations, including a significant ceiling effect and a lack of validation [3,11].

As regards the results of the SF-36 score, our results supported by Haskell and Kim [12] who reported that physical function improved from 37.3±8.9 to 41.5±7.9 (P <0.05) after surgery.

Moreover, our results disagree with Gjertsen *et al.*, [13] who reported that a large proportion of patients reported experiencing issues following the surgery. At the 4- and 12-month follow-ups, 71% and 58% of the patients reported experiencing walking difficulties, respectively.

The mobility of patients was significantly impacted by the hip fracture. After four months, the proportion of patients with chronic cognitive impairment (CCI) who were constrained to their beds increased by fivefold from 3% to 16%, while the percentage of patients without CCI increased from 0.9 to 3.0% (P<0.001). The proportion of patients with CCI who were unable to wash or dress nearly doubled, from 25 to 48%. Additionally, the proportion of patients with CCI who were unable to engage in their typical activities rose from 45 to 63%. Hip fracture patients with CCI (Kristoffersen *et al.*) [14].

Our findings showed that the mean score of role limitations due to physical health was (23.28±12.87) at 3 months changed to (66.96±35.39) at 6 months and to (86.54±21.48) after 12 months. There was a statistically significant rise in scores of role limitations due to improved physical health from to 3 months to 6 and 12 months. (P<0.001). The mean score of role limitations due to emotional health was (62.23±38.25) at 3 months changed to (82.11±33.34) at 6 months and to (94.85±20.46) after 12 months. Compared with the previous three months, there was a statistically significant increase in scores of and improvement in role limitations due to emotional health at 6 and 12 months (P<0.001).

Our findings showed that the mean score of energy/fatigue was (57.83±14.78) at 3 months changed to (71.79±15.65) at 6 months and to (85.60±12.19) after 12 months. There was a statistically significant steady rise in energy/fatigue from to 3 months to 6 and 12 months (P<0.001). The mean score of emotional well-being was (72.80±13.39) at 3 months changed to (84.29±12.60) at 6 months and to (91.35±11.14) after 12 months. There was statistically significant rise in emotional well-being at 6 and 12 months compared with 3 months (P<0.001).

Kristoffersen *et al.*, [14] reported that hip fracture patients with CCI experienced an rise in extreme symptoms from 7.4 to 9.7% after 4 months in terms of anxiety and depression.

Table 2 Physical functioning, role limitations due to physical, and emotional health, energy/fatigue, emotional well-being, social functioning, pain, general health, and health change at 3, 6, and 12 months in the studied patients according to short form 36 score (SF-36)

	Physical functioning			*P* value
	Mean±SD	95% Confidence Interval for Mean		
At 3 months	53.83±17.5	47.65	60.97	
At 6 months	78.21±19.35	70.71	85.72	**<0.001***
At 12 months	93.27±9.27	89.53	97.01	
Role limitations due to physical health				
At 3 months	23.28±12.87	13.79	32.76	
At 6 months	66.96±35.39	53.24	80.69	**<0.001***
At 12 months	86.54±21.48	77.86	95.22	
Role limitations due to emotional problems				
At 3 months	62.23±38.25	13.79	32.76	
At 6 months	82.11±33.34	53.24	80.69	**<0.001***
At 12 months	94.85±20.46	77.86	95.22	
Energy/fatigue				
At 3 months	57.83±14.78	52.04	63.48	
At 6 months	71.79±15.65	65.72	77.85	**<0.001***
At 12 months	85.60±12.19	80.57	90.63	
Emotional well-being				
At 3 months	72.80±13.39	67.40	77.71	
At 6 months	84.29±12.60	79.40	89.17	**<0.001***
At 12 months	91.35±11.14	86.85	95.85	
Social functioning				
At 3 months	54.86±21.00	46.87	62.85	
At 6 months	84.89±17.75	78.01	91.78	**<0.001***
At 12 months	94.00±11.99	89.16	98.84	
Pain				
At 3 months	58.55±14.20	53.15	63.96	
At 6 months	80.56±17.35	73.69	87.42	**<0.001***
At 12 months	92.58±13.34	87.19	97.96	
General health				
At 3 months	58.28±14.66	52.63	63.92	
At 6 months	70.93±15.57	64.77	77.08	**<0.001***
At 12 months	84.92±16.08	78.43	91.42	
Health change				
At 3 months	16.21±12.13	10.07	22.34	
At 6 months	32.69±11.77	24.85	35.49	**<0.001***
At 12 months	92.71±13.75	80.31	98.53	

Data are presented as mean±SD.
*: Significant *P* value as less than 0–05.

Our findings showed that the mean score of social functioning was (54.86±21.00) at 3 months changed to (84.89±17.75) at 6 months and to (94.00±11.99) after 12 months. There was statistically significant rise in social functioning at 6 and 12 months compared with 3 months ($P<0.001$) The mean score of pain was (58.55±14.20) at 3 months which changed to (80.56±17.35) at 6 months and to (92.58±13.34) after 12 months. There was statistically significant rise in pain at 6 and 12 months compared with 3 months ($P<0.001$).

Our findings were consistent with Kristoffersen *et al.* [14] who reported a rise in both moderate and extreme pain/discomfort from 44 to 64% and 5.7 to 8.9%, respectively, after 4 months.

The potential of networked medical devices is to enable clinicians to monitor physiological measures and symptoms at home, as well as to provide them with a more refined and nuanced understanding of the lived experiences of individuals affected by a variety of chronic conditions [15]. The term 'RPM' is commonly used to describe this type of mobile health care (mHealth). It is defined as 'the utilization of wearable, noninvasive device that autonomously transmits data to a web portal or mobile application for health provider evaluation, patient self-monitoring and clinical decision-making' [16].

Proponents of RPM emphasize the potential for enhanced patient outcomes, increased physician satisfaction, and reduced costs [17]. Additionally, it

is proposed that RPM will enhance the timeliness of care, enhance treatment adherence, and promote personalized preventive medicine.

The limitations of the study are the sample size was relatively small, and the investigation was conducted in a single facility.

We recommend that further studies be conducted using well-designed randomized controlled trials or larger comparative observational studies to accurately assess long-term outcomes. Furthermore, the sample size of future studies should be adequate to ensure that they can draw meaningful conclusions and account for confounding factors. To validate the generalizability of our findings, future research should include multicenter studies and be conducted over a longer period.

Conclusions

Our research indicates that communication with patients who have acetabular fractures can be enhanced through the use of a RPM system that employs a mobile phone call program. Over one year, the majority of patients completed the trial and observed substantial enhancements in their emotional well-being, pain management, and physical function.

Ethics approval and consent to participate

It was approved by the ethics committee of Faculty of Medicine, from December 2021 to March 2022 (approval No:17101431). An informed written consent was obtained from the participants.

Consent for publication

All authors give their consent for publication in the journal.

Availability of data and material

Data and material are available on a reasonable request from the author.

Authors' contributions

AMA and MM conceived and supervised the study; MKA and OAF were responsible for data collection. OAF and AMA analyzed and interpreted the data. All authors provided comments on the manuscript at various stages of development. All authors read and approved the final manuscript.

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Nil.

Conflicts of interest

There are no conflicts of interest.

Abbreviation

OA, osteoarthritis
PROMs, patient-reported outcome measures
RPM, remote patient monitoring
SF-36, 36-item short form
THA, total hip arthroplasty

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