

The Effects of QR Code-Supported Training on Cast-Related Problems at Home and Quality of Life in Patients with a Cast: A Pilot Randomized Controlled Study

Alçılı Hastalarda QR Kod Destekli Öğretimin Evde Alçı ile İlgili Yaşanan Sorunlar ve Yaşam Kalitesi Üzerine Etkisi: Randomize Kontrollü Pilot Çalışma

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ABSTRACT Objective: Many individuals who have cast after fractures experience cast-related problems due to a lack of knowledge. The lack of knowledge about cast care leads to difficulties in properly managing the cast, resulting in various problems during the healing process. The aim of this randomized controlled study is to examine the effect of a QR code-supported training on cast-related problems at home and quality of life in patients with a cast. **Material and Methods:** A total of 40 participants were randomly assigned to the intervention ($n=20$) and control ($n=20$) groups. The intervention group was given QR code-supported patient training. Data were collected with "Patient Information Form", "Form for Problems Experienced with the Cast at Home" and "SF-36 Quality of Life Scale". In the evaluation of the data, descriptive statistics (mean, standard deviation, frequency, and percentage), Mann-Whitney U test, Spearman correlation coefficient, chi-square test, Mixed Design ANOVA test, and Bonferroni-Dunn test were used. Study findings were reported based on the CONSORT Statement. **Results:** After QR code-supported training, the intervention group experienced significantly reduced problems and higher quality of life scores ($p<0.05$). The rate of admission to the emergency department was lower in the intervention group ($p=0.011$). It was determined that the problems experienced with the cast were negatively correlated with the quality-of-life scores ($p<0.05$). **Conclusion:** QR code-supported training reduced the problems associated with the cast at home and positively impacted the quality of life. Additionally, QR-supported training was identified as a nursing intervention that reduces hospital readmissions.

Keywords: Patients; QR-code supported training; cast; nursing; quality of life

ÖZET Amaç: Alçı uygulaması sonrası pek çok birey bilgi eksikliği nedeni ile alçı ile ilgili sorunlar yaşamaktadır. Alçı bakımı hakkındaki bilgi eksikliği alçının doğru bir şekilde yönetilmesinde zorluklara yol açar ve iyileşme sürecinde çeşitli sorunlara neden olur. Bu randomize kontrollü çalışmanın amacı, alçılı hastalarda QR kod destekli öğretimin evde alçı ile ilgili yaşanan sorunlar ve yaşam kalitesi üzerindeki etkisini incelemektir. **Gereç ve Yöntemler:** Toplam 40 katılımcı rastgele olarak müdahale ($n=20$) ve kontrol ($n=20$) gruplarına atanmıştır. Müdahale grubuna QR kod destekli hasta öğretimi verilmiştir. Veriler "Hasta Bilgi Formu", "Evde Alçıyla İlgili Yaşanan Sorunlar Formu" ve "SF-36 Yaşam Kalitesi Ölçeği" ile toplanmıştır. Verilerin değerlendirilmesinde tanımlayıcı istatistikler (ortalama, standart sapma, frekans ve yüzdelik), Mann-Whitney U testi, Spearman korelasyon katsayısı, ki-kare testi, Karma Desen ANOVA testi ve Bonferroni-Dunn testi kullanılmıştır. Çalışma bulguları CONSORT Bildirgesi'ne uygun olarak rapor edilmiştir. **Bulgular:** QR kod destekli öğretimin sonrasında müdahale grubunda yaşanan sorunlar ölçüde azalmış ve yaşam kalitesi puanları daha yüksek bulunmuştur ($p<0.05$). Müdahale grubunda acil servise başvuru oranı daha düşük bulunmuştur ($p=0.011$). Alçı ile ilgili yaşanan sorunlar ile yaşam kalitesi puanları arasında negatif yönlü bir ilişki olduğu belirlenmiştir ($p<0.05$). **Sonuç:** QR kod destekli öğretimin, evde alçıyla ilgili sorunları azaltmış ve yaşam kalitesini olumlu etkilemiştir. Ayrıca, QR destekli öğretimin hastaneye geri dönüşleri azaltan bir hemşirelik müdahalesi olduğu saptanmıştır.

Anahtar Kelimeler: Hastalar; QR kod destekli hasta eğitimi; alçı; hemşirelik; yaşam kalitesi

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Cast applications are valuable practices that provide healing in fractures and dislocations; however, during and after the cast applications, patients experience many problems (such as embolism, pressure sores, infection, joint stiffness, disability, or depression) that negatively affect their quality of life.^{1,2} The healing process in individuals with fractures can last for weeks or months. This situation places more responsibilities on individuals, such as undertaking care at home after the cast application in patients with fractures, management of health-related conditions, and helping the progress of the treatment process positively.³

Patient training is an important nursing intervention to provide effective care, meet treatment needs, and prevent complications in individuals with a cast as it eliminates the lack of knowledge, enables individuals to adapt to the situation, facilitates the process, and increases their quality of life.^{4,5} Some studies have shown that individuals with fractures need information about many issues such as self-care, the healing process, and possible complications.^{6,7} This shows that patient training is extremely important to prevent problems. Nurses provide patient training by using many audio-visual teaching methods and techniques.⁸

QR codes, which have recently been used in the field of health in the literature, are fast, easy to use, and cost-effective, provide unlimited access to information, and allow information updates. These features make QR codes effective patient training tools.⁹ A QR code is an array of black and white squares arranged in a square grid, readable by scanners and smartphones. It provides easy access to a website, email, or text message.¹⁰ Therefore, it is possible to expand the training environment by directing learners to relevant websites with URL links placed in QR codes without exposure to information pollution.¹¹ In this context, QR codes act as a bridge between the real and the virtual world and are very important in terms of providing instant access to information from personal devices, with no time and place restrictions. However, when the literature is examined, it is seen that there are no randomized controlled studies on the examination of the effectiveness of QR codes in the training of patients with a cast in Türkiye. A few pre-

vious studies have shown that patients find QR codes reliable, and that this application can be used proactively in solving problems.¹²⁻¹⁵ In this context, it is thought that the current randomized controlled trial has clinical importance as it focuses on reducing problems experienced during the healing process and increasing the quality of life in patients with a cast. Today, internet usage rates are gradually increasing in both young and elderly populations and technology-supported applications are becoming individuals' focus of attention.^{5,16} In this context, it has become crucial to integrate technology into nursing interventions to provide effective patient training. The hypothesis of this study was that QR code-supported patient training would reduce the problems related to home plaster cast care and positively impact the quality of life in patients with cast. Therefore, the study was planned to examine the effects of a QR code-supported training on cast-related problems experienced at home and the quality of life in patients with a cast.

MATERIAL AND METHODS

DESIGN AND SAMPLE

This parallel-group, single-blind randomized controlled trial was conducted in a training and research hospital's orthopedics and traumatology clinic in Türkiye (November 2021-July 2022). It is recommended to have a sample size of 12 per group as a rule of thumb for a pilot study;¹⁷ Because in the design of a parallel group trial a sample size of 12 per group is a good round number. It is divisible by 2, 3, 4 and 6 and so facilitates the setting of a variety of block sizes. Taking possible dropouts into account for a 6-week follow-up, we included 40 participants in this study (control group: 20; intervention group: 20) who met the criteria were randomly assigned to the intervention and control groups in equal proportions. In the post-power analysis performed using the power analysis method with the G-Power 1.3 program (Heinrich-HeineUniversität Düsseldorf, Germany), the effect size was found to be 0.89, the Type I error margin (α)=0.05, and the strength of the test ($1-\beta$) was found to be 95%.

This study was approved by the Institutional Review Board of the Yozgat Bozok University Uni-

versity (date: 13.10.2021; no: 2017-KAEK-189_2021.10.13_06). The study was carried out in accordance with the Declaration of Helsinki. Written and verbal consent was obtained from all participants before the study was initiated.

PARTICIPANTS

The study included individuals who presented to the orthopedics and traumatology clinic of a training and research hospital in Türkiye with fracture complaints, was applied a cast, and met the research criteria. Individuals who had lower and upper extremity fractures had a short cast, wore a cast for at least 6 weeks, were literate, were aged ≥ 18 years, agreed to participate in the study, had a smartphone, and were able to access the Internet via their phones were included in the study. Individuals who had a previous history of fracture and psychological problems were not included in the study. A total of 57 participants were evaluated during the study, 10 were excluded as they did not meet the research criteria and seven were excluded because they did not agree to participate in the study (Figure 1).

RANDOMIZATION, ASSIGNMENT, AND BLINDING

Participants were randomly assigned to intervention and control groups. Groups were stratified according to age and gender, and participants were assigned to groups by block randomization. Randomization was carried out by creating a table of random numbers on a website (<https://www.randomizer.org>) by a faculty member who was not involved in the study. Participants were assigned to the groups in a 1:1 ratio by forming blocks of 5 to 6 combinations. The practicing researcher evaluated participants in terms of inclusion criteria, obtained participants' consent, made pre-tests, and learned about participants' groups by telephone after making pre-tests. After the application, questionnaires were completed by a skilled nurse blinded to the groups outside the study. In the study, it was stated that the participants in both groups were given technology-supported training. However, they were not given detailed information about teaching methods and groups, and therefore they were blinded. In the statistical analysis and reporting phases of the study, the groups were named A and B, and the researchers were blinded to these phases.

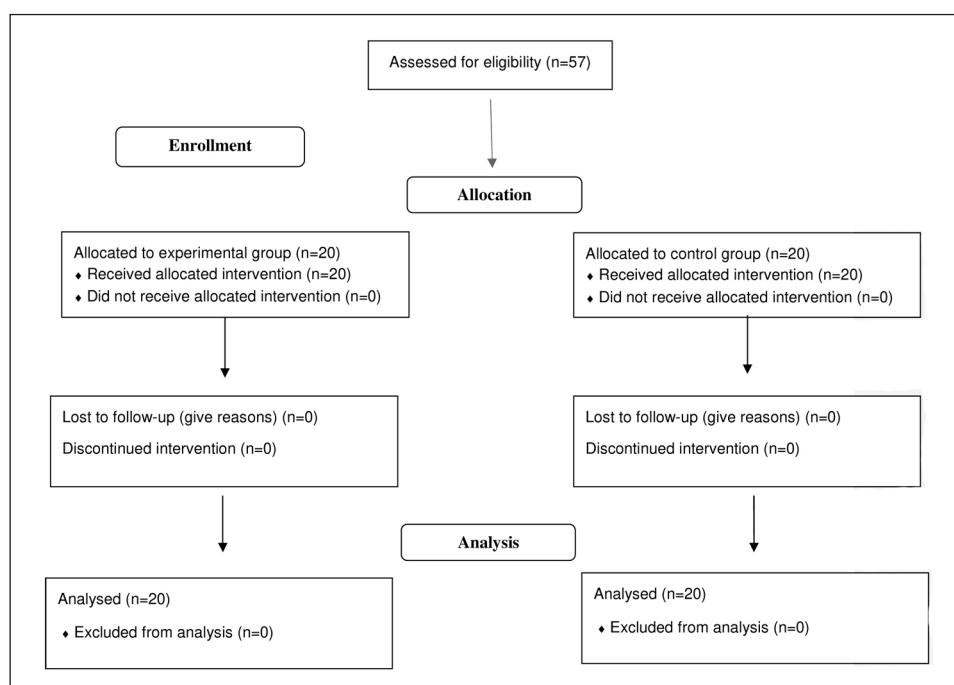


FIGURE 1: Participants flow diagram.

CREATION OF THE PATIENT TRAINING PLAN AND THE QR CODE

The aim of the patient training plan was to train patients about cast applications by using QR codes. For this purpose, first, a patient training booklet was created by the researchers based on the literature.^{3,18,19} The booklet consisted of three parts: general information about fractures; information about casts and cast care; home care. It was submitted to the opinions of nine faculty members who were experts in the field of orthopedics and nursing for assessment.

In line with the content of the booklet, the researcher and an orthopedic doctor created 2-3-minute-long videos using a video camera. These videos cover various topics, including definition of fracture and plaster, problems that may be experienced about cast (such as pain, swelling, circulatory disorders, lack of pulse, purple appearance on the nails, paleness, increase in body temperature, infection, embolism, compartment syndrome, joint stiffness, etc.,), practices to be done for cast care (such as keeping the cast dry and clean, exercising nearby joints not limited by the cast, preventing edema by keeping the arm or leg with the cast elevated above heart level, applying cold therapy, correctly using medications like analgesics and blood thinners, neurovascular evaluations, and balanced nutrition etc.,), patient safety precautions at home (such as using non-slip mats, ensuring well-lit surroundings, using handrails), and situations that require immediate medical attention (such as increasing pain, shortness of breath, and chest pain etc.,). The videos were submitted to the opinions of the nine faculty members. Later, a blank web page was created by using WordPress scripts and plugins, PHP, HTML, CSS, and JS with the support of a computer engineer. The web page worked efficiently on Linux Server and was user-friendly. Users could upload, delete, or update the content that they want in any format. Using all these features, the patient training booklet and videos created in the study were integrated into the page. The home page of the website was designed using attractive visuals and the purpose of the page and the contact information of the researchers were presented. Participants scrolled the page up and down to access the training booklet and the videos just below

it. For ease of use, all information was presented on the same page. A QR code was created using the URL (Uniform Resource Locator) of the created web page and the free QR code generator tool on the Internet to access the page with a QR code. The QR code created was printed as many as the number of participants and placed on patient wristbands, which were waterproof and could be adjusted according to the patient's arm. Patient wristbands are used in the clinical routine to place patient identification labels inside.

APPLICATION

Pre-application

Before proceeding with the application phase of the study, a pre-application was performed on six patients who met the inclusion criteria. There was no problem with the questionnaires and the QR code application. Pre-application patients were not included in the study.

Application

After the cast application, individuals who met the inclusion criteria were informed about the study, their consent was obtained, and the pre-tests (Patient Information Form and SF-36 Quality of Life Scale) were applied by the researcher face-to-face. Later, participants' groups were learned by telephone, and they were assigned to the intervention and control groups.

Participants in the intervention group were fitted with a wristband and the QR code. At the same time, participants and their relatives were informed about the use of the QR code, and their phones were checked to make sure whether the QR code scanner application had been downloaded. It was downloaded to the phones of participants for free and all of them were taught how to use it. Then, the patient training booklet prepared by the researchers was opened through the application and the training was carried out using various teaching methods such as lecturing, question-answers, and demonstrations. Patient training was carried out in a suitable environment as much as possible. In addition, participants were given the contact information of the researcher (telephone number and address) and informed that they could receive

consultancy services when necessary. They were told that this information could also be accessed using the QR code. Participants were informed that they could access all information at any time and as many times as they wanted by using the QR code. When the participants came to the polyclinic for the removal of the cast (six weeks later), they were interviewed face-to-face, and the data collection form about problems experienced at home and the SF-36 Quality of Life Scale was filled out. Participants were contacted weekly via telephone to check the use of the QR code.

Unlike the intervention group, participants included in the control group watched the content of a Word file containing clinical information about cast application on a tablet computer for a short time and they were told that they were provided with technology-supported training. No other intervention was applied to the control group. Participants in the control group applied routine hospital follow-up and treatment procedures.

Measurements

Patient Information Form: This form was prepared by the researchers following a review of the literature. The form consists of socio-demographic characteristics, information about previous health status, and fractures.^{3,19,20}

Form for Problems Experienced with the Cast at Home: This form was created by the researchers to determine cast-related problems that patients experienced at home during the healing process.²¹⁻²³ The form consisted of questions about who received support during the recovery process at home when to go to the control, what kind of problems were experienced during the recovery process, and the status of presenting to the emergency department.

SF-36 Quality of Life Scale: This scale was developed by Ware in 1992 and its Turkish validity and reliability study was carried out by Koçyiğit et al.²⁴ The scale consisted of 36 questions and eight sub-dimensions (physical functioning, physical role limitation, pain, general health perception, energy/fatigue/vitality, social functioning, emotional role limitation, and mental health). Each item on the scale is scored between 0 and 100. The higher the score is, the higher

the quality of life is. Cronbach's α coefficient of each subscale was calculated separately, and they were found to range between 0.732 and 0.761. Cronbach's α coefficients in this study ranged between 0.793 and 0.897.

DATA ANALYSIS

Data were analyzed using the statistical package program IBM SPSS Statistics Standard Concurrent User V 26 (IBM Corp., Armonk, New York, USA). Descriptive statistics (mean, standard deviation, frequency, and percentile) were used for categorical and continuous variables. The Mann-Whitney U test was used to evaluate differences between two independent groups as parametric test prerequisites were not met. Correlations between two continuous variables were evaluated with the Spearman correlation coefficient. Correlations between categorical variables were analyzed with the chi-square test. In our analysis, a mixed-design ANOVA and the Bonferroni-Dunn test, one of the multiple comparison tests, were used to make an overall assessment between repeated measurements and groups. A level of $p<0.05$ was considered statistically significant.

RESULTS

Intervention/control groups were homogeneously distributed according to all descriptive characteristics except body mass index ($p>0.05$) (Table 1). It was found that control group participants experienced statistically significantly more physical and psychosocial problems than those in the intervention group during the healing period after the cast application ($p<0.05$) (Table 2). After the training intervention, the participants in the intervention group had higher scores on the subscales (apart from emotional role limitation) of the Quality-of-Life Scale compared to those in the control group. It was found that the problems experienced with the use of cast were negatively correlated with the Quality-of-Life Scale scores ($p<0.05$) (Table 3). It was determined that the scores on the Quality-of-Life Scale decreased as the problems increased (Table 4). Also, the rate of admission to the emergency department was statistically significantly lower in the intervention group than in the control group ($p<0.05$) (Table 5).

TABLE 1: Distribution of descriptive characteristics of the participants by groups (n=40).

	Study groups		Test statistics	
	Control (n=20)	Intervention (n=20)	Test value	p value
Age, (Years) X±SD	53.40±12.39	52.00±14.14	-0.325 ^a	0.745
Gender, n (%)				
Woman	10 (50.0)	10 (50.0)	0.001 ^b	p>0.999
Man	10 (50.0)	10 (50.0)		
Body mass index, (kg/m ²) X±SD	26.93±1.46	24.96±0.99	-4.141 ^a	0.001*
Educational status, n (%)				
Primary school	7 (35.0)	7 (35.0)	0.195 ^b	0.907
Secondary education	10 (50.0)	9 (45.0)		
High education	3 (15.0)	4 (20.0)		
Income status, n (%)				
Income less than expenses	5 (25.0)	0 (0.0)	5.985 ^b	0.058
Income equals to expense	11 (55.0)	13 (65.0)		
Income more than expenses	4 (20.0)	7 (35.0)		
Cause of fracture, n (%)				
Fall	16 (80.0)	17 (85.0)	0.173 ^b	0.677
Sports injury	4 (20.0)	3 (15.0)		
Area of the fracture, n (%)				
Wrist	6 (30.0)	7 (35.0)	1.077 ^b	0.783
Foot	4 (20.0)	2 (10.0)		
Ankle	9 (45.0)	9 (45.0)		
Lower leg	1 (5.0)	2 (10.0)		
Chronic disease, n (%)				
No	11 (55.0)	14 (70.0)	0.960 ^b	0.327
Yes	9 (45.0)	6 (30.0)		
Information about cast, n (%)				
No	17 (85.0)	17 (85.0)	0.001 ^b	p>0.999
Yes	3 (15.0)	3 (15.0)		
Living arrangement, n (%)				
Spouse	12 (60.0)	10 (50.0)	0.001 ^b	p>0.999
Spouse and children	8 (40.0)	8 (40.0)		
Other	0 (0.0)	2 (10.0)		

*p<0.05; aMann-Whitney U Test (z); bChi-square test (χ^2); Summary statistics are given as mean±standard deviation for numerical data and number (percentage) for categorical data; SD: Standard deviation.

DISCUSSION

In our study, it was seen that the QR code-supported patient training reduced the problems experienced by individuals with a cast and increased their quality of life.

In the study, physical and psychosocial problems with the cast, such as pain, limitation of movement, and anxiety, were experienced by participants in both groups, which was consistent with the literature.^{23,25}

Our findings showed that problems experienced with the cast were fewer in the intervention group, which was consistent with the hypothesis of the study. Since the literature is limited on QR Code-supported training in patients with cast, we couldn't discuss our results in detail. Yet, our study results suggest that QR code-supported patient training can improve individuals' adaptation to cast applications, cope with problems effectively, and manage the healing process at home more easily. Patient training is important to en-

TABLE 2: Distribution of the problems experienced by the participants regarding cast at home according to groups (n=40).

Problems		Control (n=20)	Intervention (n=20)	χ^2	p*
	n (%)	n (%)			
Physical problems	Pain	20 (100.0)	16 (80.0)	4.444^a	0.035
	Swelling	14 (70.0)	3 (15.0)	12.379^a	p<0.001
	Numbness	5 (25.0)	0 (0.0)	5.714^a	0.017
	Itching	15 (75.0)	8 (40.0)	5.013^a	0.025
	Loss of feeling	1 (5.0)	0 (0.0)	1.026 ^a	0.311
	Bruising	2 (10.0)	0 (0.0)	2.105 ^a	0.147
	Tight cast	10 (50.0)	0 (0.0)	13.333^a	p<0.001
	Loose cast	2 (10.0)	0 (0.0)	2.105 ^a	0.147
	Puncture in plaster	5 (25.0)	0 (0.0)	5.714^a	0.017
	Limitation of movement	18 (90.0)	12 (60.0)	4.800^a	0.028
	Weight gain	12 (60.0)	0 (0.0)	10.989^a	0.001
	Constipation	10 (50.0)	0 (0.0)	13.333^a	p<0.001
	Not having a bath	9 (45.0)	0 (0.0)	11.613^a	0.001
	Not doing housework	6 (30.0)	0 (0.0)	7.059^a	0.008
	Getting the cast wet	6 (30.0)	0 (0.0)	7.059^a	0.008
Psychosocial problems	Pale skin	3 (15.0)	0 (0.0)	3.243 ^a	0.072
	Sleep disorder	10 (50.0)	0 (0.0)	13.333^a	p<0.001
	Fatigue	4 (20.0)	0 (0.0)	4.444^a	0.035
	Anxiety	8 (40.0)	0 (0.0)	10.000^a	0.002
	Loneliness	5 (25.0)	0 (0.0)	5.714^a	0.017
	being dependent on others	18 (90.0)	6 (30.0)	15.000^a	p<0.001
	Inability to participate in social activities	10 (50.0)	0 (0.0)	10.157^a	0.001
	Limitation in sexual life	4 (20.0)	0 (0.0)	4.444^a	0.035
	Limitation at work	6 (30.0)	0 (0.0)	7.059^a	0.008
	Fear of falling again	2 (10.0)	0 (0.0)	2.105 ^a	0.147

*p<0.05; ^aChi-square test (χ^2).

able patients to cope with problems, maintain their care, and have a more comfortable recovery process.^{5,26} Besides, it is known that using technology-supported methods in patient training increases the effectiveness of training.²⁷

In our study, it was determined that cast-induced problems affected the quality of life negatively and that the quality-of-life scores decreased as the problems increased. Similarly, previous studies have shown that problems experienced in the post-fracture healing process negatively affect the quality of life.^{1,2} The needs of people with a cast are different from those who are hospitalized because most individuals with a cast are normally healthy and spend very little time in the hospital. This situation places more responsibilities on individuals, such as undertaking care at home after the cast application in patients with fractures, management of health-related conditions,

and helping the progress of the treatment process positively. Since a person with a cast will take on a significant part of their care, the necessity of training becomes more evident here. At this point, nurses need to prepare individuals with a cast for their own care and responsibilities.³ Because, as stated in the literature, failure to fully understand how to deal with cast-related problems that may be encountered at home and failure to fulfill responsibilities will increase the problems experienced in the healing process and adversely affect the quality of life.^{13,28} In the current study, intervention group patients were given training on topics such as problems that may be experienced about cast, practices to be done for cast care, patient safety precautions at home, situations that require immediate medical attention, and after the training, it was observed that the problems experienced by the patients with the cast decreased and quality of

TABLE 3: Comparison of participants' quality of life scale scores before and after education (n=40).

	Study groups		Test statistics ^a		Group x time effect
	Control n=20	Intervention n=20	F	p	
	$\bar{X} \pm SD$	$\bar{X} \pm SD$			
Physical functioning					$F=2306.72; p=0.001; \eta^2=0.984; power=0.999$
Before education	4.25±8.16	1.75±5.91	1.232	0.274	
After education	5.25±9.80	99.75±1.12	1836.80	0.001	
Test statistics ^b	F=0.49; p=0.488	F=4709.05 p=0.001			
Physical role limitation					$F=116.25; p=0.001; \eta^2=0.754; power=0.999$
Before education	95±22.36	92.50±23.8	0.121	0.73	
After education	7.50±18.20	100.00±0.0	510.02	0.001	
Test statistics ^b	F=1.44 p=0.236	F=197.24 p=0.001			
Emotional role limitation ^d					$F=662.10; p=0.001; \eta^2=0.947; power=0.999$
Before education	76.67±0.0	76.67±0.00	0.001	p>0.999	
After education	99.70±2.8	6.96±2.38	662.10	0.001	
Test statistics ^b	F=94.04 p=0.718	F=860.95 p=0.001			
Vitality					$F=55.64; p=0.001; \eta^2=0.594; power=0.999$
Before education	35.75±11.84	36.75±16.8	0.047	0.829	
After education	23.25±11.62	65.25±14.3	100.23	0.001	
Test statistics ^b	F=10.34 p=0.003	F=53.77 p=0.001			
Mental health					$F=57.34; p=0.001; \eta^2=0.601; power=0.999$
Before education	43.80±8.26	44.40±11.8	0.036	0.85	
After education	32.60±10.88	71.00±17.1	70.56	0.001	
Test statistics ^b	F=10.06 p=0.003	F=56.79 p=0.001			
Social functioning					$F=143.54; p=0.001; \eta^2=0.791; power=0.999$
Before education	20.00±27.92	9.38±12.08	2.439	0.127	
After education	11.25±3.85	91.25±10.1	972.80	0.001	
Test statistics ^b	F=2.67 p=0.110	F=234.32 p=0.001			
Pain					$F=84.89; p=0.001; \eta^2=0.691; power=0.999$
Before education	19.75±28.25	12.88±13.8	0.96	0.333	
After education	19.25±13.18	88.00±9.65	354.17	0.001	
Test statistics ^b	F=0.07 p=0.932	F=167.54 p=0.001			
General health perception					$F=218.76; p=0.001; \eta^2=0.852; power=0.999$
Before education	21.00±12.42	23.50±9.47	0.512	0.478	
After education	18.75±12.23	88.25±11.5	342.60	0.001	
Test statistics ^b	F=0.49 p=0.487	F=408.63 p=0.001			

^aIntergroup comparison; ^bIntragroup comparison; ^cEffect size (partial η^2) conventions: small effect=0.01; medium effect=0.06; large effect=0.14. F: Mixed between-within-subject analysis of variance (ANOVA). Summary statistics are given as mean±standard deviation (SD). The parts determined in bold are statistically significant ($p<0.05$). ^dSince the baseline values (before education) were different, baseline values were determined as covariate variables and baseline correction was made. Descriptive statistics for the baseline effect were given as mean±standard error.

life scale scores increased significantly. In a systematic review by Raybould et al., it was stated that the majority of individuals did not receive effective patient training after fracture and were in need of training.⁶ In the same study, it was emphasized that patients whose information needs were not met faced many physical and psychosocial problems and their quality of life was adversely affected. No study has been found in the literature examining the effects of

QR Code-supported training plans on quality of life. However, Cho et al. in orthotic patients, Azad et al. in surgical patients, stated that, QR Code supported training plan was liked by the patients and it was satisfactory.^{29,30} Considering that patient satisfaction is a concept related to quality of life, these results are thought to be comparable with the results of the current study. In this context, in the current study, the increase in the quality-of-life scale scores of the in-

TABLE 4: The relationship between some problems experienced in cast usage and quality of life scores (n=40).

Problems	Physical functioning	Physical role limitation	Emotional role limitation	Vitality	Mental health	Social functioning	Pain	General health perception
Pain	-0.75 (0.001)	-0.75 (0.001)	0.75 (0.001)	-0.70 (0.001)	-0.72 (0.001)	-0.74 (0.001)	-0.70 (0.001)	-0.71 (0.001)
Swelling	-0.67 (0.001)	-0.63 (0.001)	0.63 (0.001)	-0.50 (0.001)	-0.46 (0.002)	-0.68 (0.001)	-0.64 (0.001)	-0.64 (0.001)
Itching	-0.56 (0.001)	-0.58 (0.001)	0.58 (0.001)	-0.36 (0.022)	-0.31 (0.047)	-0.54 (0.001)	-0.55 (0.001)	-0.43 (0.005)
Limitation of movement	-0.57 (0.001)	-0.52 (0.001)	0.52 (0.001)	-0.51 (0.001)	-0.53 (0.001)	-0.55 (0.001)	-0.45 (0.003)	-0.59 (0.001)
Sleep disorder	-0.57 (0.001)	-0.55 (0.001)	0.55 (0.001)	-0.44 (0.004)	-0.50 (0.001)	-0.53 (0.001)	-0.37 (0.018)	-0.50 (0.001)
Anxiety	-0.52 (0.001)	-0.47 (0.002)	0.47 (0.002)	-0.43 (0.005)	-0.48 (0.001)	-0.47 (0.002)	-0.37 (0.018)	-0.42 (0.006)
Being dependent on others	-0.70 (0.001)	-0.72 (0.001)	0.72 (0.001)	-0.68 (0.001)	-0.64 (0.001)	-0.71 (0.001)	-0.74 (0.001)	-0.70 (0.001)
Constipation	-0.78 (0.001)	-0.55 (0.001)	0.55 (0.001)	-0.44 (0.004)	-0.49 (0.001)	-0.53 (0.001)	-0.36 (0.021)	-0.43 (0.005)

p<0.05; Spearman correlation coefficient (r_s).

tervention group after training compared to that of the control group suggested that the QR code-supported patient training had a positive effect on patients' quality of life, which was consistent with the hypothesis of the study.

The current study showed that the rate of emergency department admissions during the recovery period was lower in patients in the intervention group than in the control group, and the problems reported in the admission were lower. A notable finding here was that all patients in the control group who presented to the emergency department with pain, swelling, numbness, itching, and tight cast were treated as outpatients without requiring hospitalization. This suggests that patients should be trained about issues they can manage themselves. It is well known that emergency department admission is a significant quality indicator because it is associated with increased costs in the healthcare system.³¹ Although precise results could not be revealed since health costs were not included in the main purpose of this study, lower rates of admission to the emergency department in the intervention group suggest that QR code-supported patient training can reduce health costs by preventing repeated admissions to the hospital. Previous studies have indicated that patients' admission to the emergency department due to cast-related problems was associated with ineffective costs.^{32,33} For this reason, this shows that QR code-supported patient training planning of nurses is important for both effective care and cost-effectiveness.

Today, it has become important for nurses to use technology-supported applications for effective patient training.⁸ It is known that fracture clinics are not suitable areas for training due to patient density, and permanence cannot be ensured due to the bulk of information provided.⁶ At this point, features of the QR code, which is a technological innovation, such as fast and easy to use and cost-effective, providing unlimited access to information, and allowing information updates, make this application an effective patient training tool.⁹ It is an application that individuals can use repeatedly at their fingertips at any time and as many times as they want, without time and place restrictions.¹¹ At the same time, it reduces the risk of cross-contamination by preventing contact with surfaces such as paper and brochures and provides significant advantages in the fight against COVID-19.¹² Moreover, this is an economical and environmentally friendly application that prevents waste of paper and allows updates by using a single QR code.³⁴ All these suggest that QR code-supported patient training is effective. However, despite all these, it has also been stated that there are barriers to the use of the QR code due to some technical features, such as the availability of smartphones, data security, time and personnel requirement for

TABLE 5: Emergency admission status of participants.

	Study groups		Test statistics	
	Control n (%)	Intervention n (%)	Test value	p value
Status of applying, n (%)				
Not applied	7 (35.0)	15 (75.0)	6.465 ^a	0.011*
Applied	13 (65.0)	5 (25.0)		
Reason for applying n (%) ^b				
Pain	11 (55.0)	5 (25.0)	6.022 ^a	0.645
Swelling	2 (10.0)	0 (0.0)		
Numbness	1 (5.0)	0 (0.0)		
Itching	5 (25.0)	0 (0.0)		
Tight cast	3 (15.0)	0 (0.0)		

^aChi-square test; *p<0.05; (χ^2) given as value; ^bMore than one answer was given. The percentages were taken from the applicants.

continuous updating, and Internet access.³⁵ However, both the general opinion in the literature and our study results show that QR code-supported patient training is effective. At the same time, it is thought that this application will provide both effective use of time and convenience in practice for nurses in patient training planning. In addition, it is thought that this study will contribute to the literature as it is the first randomized controlled trial on the examination of the effects of the QR code-supported training planning on the problems experienced at home and the quality of life in patients with a cast.

LIMITATIONS

The study was conducted in a single center, which is considered a limitation because it prevents the generalizability of the study results. Additionally, the inadequacy of evidence in the literature concerning the topic has limited the discussion section.

CONCLUSION

The results obtained from the study showed that QR code-supported patient training was an effective intervention in reducing cast-related problems, increasing the quality of life, and reducing repeated returns to the hospital in individuals who received training. In this respect, it is thought to be a nursing intervention that provides effective care and cost-effectiveness. Besides it is thought that QR codes, which provide unlimited access to information may

ensure the permanence of training. Moreover, it can be said that they may provide ease of use and save time for nurses in clinical applications.

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Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

Idea/Concept: Nilgün Özbaş, Murat Korkmaz; **Design:** Nilgün Özbaş, Murat Korkmaz; **Control/Supervision:** Nilgün Özbaş; **Data Collection and/or Processing:** Nilgün Özbaş, Murat Korkmaz; **Analysis and/or Interpretation:** Nilgün Özbaş, Murat Korkmaz; **Literature Review:** Nilgün Özbaş, Murat Korkmaz; **Writing the Article:** Nilgün Özbaş, Murat Korkmaz; **Critical Review:** Nilgün Özbaş, Murat Korkmaz; **References and Fundings:** Nilgün Özbaş, Murat Korkmaz; **Materials:** Nilgün Özbaş, Murat Korkmaz.

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