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The Effect of Mobile Application on Subcutaneous Anti-TNF Drug Administration in Ankylosing Spondylitis Patients: A Randomized Experimental Study

Ankilozan Spondilit Hastalarında Mobil Uygulamanın Subkütan Anti-TNF İlaç Uygulamasına Etkisi: Randomize Deneysel Bir Çalışma

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ABSTRACT

Objective: This study was conducted to develop an Android mobile application for the subcutaneous (SC) administration of anti-TNF drugs in ankylosing spondylitis patients and to evaluate its effect on drug administration.

Methods: In the first stage of this randomized experimental study, a mobile application for SC anti-TNF drug therapy was developed. In the second stage, 32 patients who met the sampling criteria were randomized to mobil and booklet groups. Patients in both groups were evaluated using the Individual Identification Form, Bath Ankylosing Spondylitis Disease Activity Index (BASDAI), the Bath Ankylosing Spondylitis Functional Index (BASFI), the Ankylosing Spondylitis Quality of Life Scale (ASQoL) and Subcutaneous Anti-TNF Treatment Questionnaire once every 6 weeks for 6 months.

Results: In the first stage, the concordance coefficient of the five experts' opinions on the information provided in the mobile application was calculated as W:0.272, *P*=.130. For both patient groups, the mean scores of BASDAI, BASFI, and ASQoL were statistically significantly lower at the last evaluation than at the first. More patients in the education booklet group had their medication applied by someone else (*P*=.011).

Conclusion: The mobile application developed for SC anti-TNF therapy in AS patients is highly informative and reliable, and it facilitates the administration of SC anti-TNF drugs to patients.

Keywords: Ankylosing spondylitis, tumor necrosis factor inhibitors, subcutaneous injections, mobile applications, nursing

ÖZ

Amaç: Bu çalışma, ankilozan spondilit (AS) hastalarının subkütan (SC) anti-TNF ilaç uygulamasına yönelik bir Android mobil uygulama geliştirmek ve bu uygulamanın ilaç uygulamasına etkisini değerlendirmek amacıyla yapıldı.

Yöntemler: Bu deneysel çalışmanın ilk aşamasında SC anti-TNF ilaç tedavisine yönelik mobil bir uygulama geliştirildi. İkinci aşamada örnekleme kriterlerini karşılayan 32 hasta mobil ve kitapçık gruplarına randomize edildi. Her iki gruptaki hastalar 6 ay boyunca her 6 haftada bir Bireysel Tanıtım Formu, Bath Ankilozan Spondilit Hastalık Aktivite İndeksi (BASDAI), Bath Ankilozan Spondilit Fonksiyonel İndeksi (BASFI), Ankilozan Spondilit Yaşam Kalitesi Anketi (ASQoL) ve Subkütan Anti-TNF Tedavi Anketi kullanılarak değerlendirildi.

Bulgular: İlk aşamada 5 uzmanın mobil uygulamada sunulan bilgilere ilişkin görüşlerinin uyum katsayısı W:0,272, *P*=.130 olarak hesaplandı. Her iki hasta grubunda da BASDAI, BASFI ve ASQoL ortalama puanları son değerlendirmede ilk değerlendirmeye göre istatistiksel olarak anlamlı derecede düşüktü. Eğitim kitapçığı grubunda ilacını başkasına yaptıran hasta sayısı daha fazlaydı (*P*=.011).

Sonuç: AS hastalarında SC anti-TNF tedavisi için geliştirilen mobil uygulamanın bilgi kalitesi ve güvenilirliği yüksek olup hastaların SC anti-TNF ilaçları uygulamasını kolaylaştırmıştır.

Anahtar Kelimeler: Ankilozan spondilit, Tümör nekroz faktörü inhibitörleri, subkütan enjeksiyonlar, mobil uygulamalar, hemşirelik

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INTRODUCTION

Ankylosing spondylitis (AS) affects the spine, sacroiliac joints, and, rarely, the peripheral joints; it causes pain, stiffness, and progressive restriction in the spine.[1] The Assessment of the SpondyloArthritis International Society (ASAS) and the European League Against Rheumatism (EULAR) recommend using biological agents alongside the traditional pharmacological treatment of AS in individuals with high disease activity.[2] Among the biological agents, five different FDA-approved anti-tumor necrosis factors (TNFs) are used in treating AS.[3] The entry of anti-TNF drugs into pharmacological treatment has changed the direction of disease management and has been effective in treatment.[4] Besides being effective, the use of a foreign protein for the drugs can cause injection-site reactions, autoantibody production, autoimmune response development, and hypersensitivity reactions. Anti-TNF drugs pose a risk for the reactivation of tuberculosis in patients with latent tuberculosis disease and can lead to serious infections, malignancy, and hematological disorders.[5] Patients should be especially careful about the possibility of infection and consult a physician in cases of fever, fatigue, or malaise. Most anti-TNF drugs (etanercept, adalimumab, certolizumab pegol, and golimumab) are administered as a subcutaneous (SC) injection, thus allowing patients to self-administer at home.[6] The self-injection procedure helps patients increase their independence and accept treatment more easily, reducing the frequency of hospital visits and reducing costs.[7] Although subcutaneous anti-TNF drugs are more preferred than intravenously administered ones due to their portability and time-saving.[6,7] These drugs require extra patient education on self-SC drug administration, storage conditions, monitoring of infections, and other side effects.[8] Furthermore, during SC injection treatment, patients may experience difficulties while administering the drug due to fear of needles, reduced manual dexterity, site pain, anxiety and skin reactions[6,9], embarrassment[9,10], difficulties while preparing the drug[10], feeling bad after an injection[9], patient lack of confidence, incorrect administration, and medication non-adherence.[11] For these reasons, informing patients about the treatment, reminding them of the treatment schedule, evaluating them at each stage of treatment, and monitoring the side effects that may develop are important for effective disease management. Nurses' continuous interaction with patients during the treatment process, which is described as “easy to talk,” plays an important role in helping patients overcome problems with chronic conditions and the need to self-administrate medication.[12] Regular follow-up of the health care team, a positive and supportive approach, and comprehensive health education on ankylosing spondylitis and drug administration increase patient medication adherence and quality of life and reduce health service utilization.[13]

Today, with the increasing popularity of smartphones, there are many easily accessible mobile health applications.[14] Studies in which mobile applications are developed for SC drug administration are limited. Domańska et al.[15] have developed a mobile application that can only be used by patients with rheumatoid arthritis treated with certolizumab pegol SC injection. In a mobile health study for AS patients, it was seen that a mobile application was developed that provides medical information about the disease and includes exercise videos for patients with axial spondyloarthritis and psoriatic arthritis.[16] In another study, a theory-based educational intervention was conducted via the social networking application WeChat on disease knowledge, self-efficacy, exercise adherence, and health outcomes in Chinese AS patients.[17] This study aimed to develop a mobile application for the SC anti-TNF drug administration of AS patients on the Android platform and to evaluate its effect on drug administration.

AIM

This study was conducted to develop an Android mobile application for the SC administration of anti-TNF drugs in AS patients and to evaluate its effect on drug administration.

Research Hypotheses

H_0: The effects of the mobile application and the education booklet on SC anti-TNF drug administration of AS patients are no different.

H_1: Mobile application is more effective compared to the education booklet on regular SC anti-TNF drug administration of AS patients.

H_2: Mobile application is more effective compared to the education booklet on SC anti-TNF drug self-administration of AS patients.

METHODS

Study Design

This randomized experimental study methodology was carried out in two stages. The first stage involved developing a mobile application for the SC anti-TNF drug administration of AS patients on the Android platform, and the second stage evaluated the mobile application’s effect on anti-TNF drug administration in AS patients. According to the CONSORT-2010 checklist, this study is reported and registered at www.clinicaltrials.gov (NCT04301128).

In the first stage of the study, the mobile application was developed in three phases: design, development, and implementation.

Phase 1. Design: In the design phase, the written material for the Android mobile application was created by the researchers in accordance with the literature. The written material was then combined with and supported by diagrams and images to reinforce learning. The written text was developed in line with the literature[18,19.] It included information about the disease, the drug (effects of the drug, storage conditions), preparation and administration of the drug (administration site, cleaning of administration site, SC injection), and post-administration processes (closure of the administration site, waste management). The application also provided reminders about when to administer the drug, how to monitor side effects such as infection and signs of allergic reaction, how to give feedback from the monitoring via the mobile application, and daily care (oral care, infection control, food preparation and consumption, personal hygiene). There was also a management panel within the application where the researcher could monitor the feedback given by the patients. The researcher could log in to this panel with a username and password and monitor the patient's treatment and drug administration, their daily body temperatures and any infections or side effects noted, as well as send information and warning messages to patients about their disease and treatment. The written material was evaluated by a total of five experts, two of whom are doctors and three of whom are nurses, who work in this field and have publications in terms of information quality and information reliability, using the DISCERN Instrument measurement tool.

Phase 2. Development: In this phase, we worked with a software company to transfer the written material to the mobile application using Android programming. The prepared material was converted into a Turkish mobile application with Android programming. Organization, harmony, presentation, interaction, and navigation elements were considered when creating the mobile application. The mobile application has been prepared with an organizational structure that is as simple and easy to use as possible to appeal to all patients (Figure 1).

Phase 3. Implementation: The applicability of the developed mobile application was checked using 5 patients who were not included in the research sample. A problem was detected in the mobile application's feedback function in this preliminary research practice. After resolving this problem, the mobile application was ready for patients' use.

Figure 1. Shows a screenshot of mobile app home page

Study Setting and Sample

In the second study, the research universe consisted of patients prescribed SC anti-TNF drugs for AS at the Rheumatology Outpatient Clinic of Eskişehir Osmangazi University, Health, Practice and Research Hospital between December 2017 and December 2019. 32 patients who met the inclusion criteria were included in the sample. Patients were assigned to the groups using a simple randomization method. The patients were assigned to the groups by drawing lots (mobile group:18; booklet group:14) (Figure 2). Post-hoc power analysis was performed using the "Chi-square Goodness-of-fit test" in the G*Power 4 program, according to the answers given by the patients to the question "How often was your medication administered by someone else?" The power of the study was found to be 0.86 (effect size:0.59) with a significance level of 0.05 for type 1 error as a result of post-hoc power analysis with 32 patients.

Inclusion and exclusion criteria

The study's inclusion criteria were receiving SC anti-TNF drugs for the first or second time, being 18 years old or over, being Turkish literate, having and being able to use an Android phone, having internet access, being able to communicate, and volunteering to participate in the research. Those who had previously received more than

two SC anti-TNF drugs, whose anti-TNF drug treatment had been terminated, and who did not want to participate in the study were excluded from the research.

Data Collection

- The first evaluation (week 0) of the patients was performed using the Individual Identification Form, the Bath Ankylosing Spondylitis Disease Activity Index (BASDAI), the Bath Ankylosing Spondylitis Functional Index (BASFI), and the Ankylosing Spondylitis Quality of Life Scale (ASQoL) tools.
- Patients in both groups were orally informed about administering anti-TNF drugs. The researcher evaluated their body temperature as per their physician's request, and they received their first treatment. The patients were given a digital thermometer for further treatments and taught how to measure their body temperature.
- The mobile application was installed via Bluetooth technology on the Android phones of the patients in the mobile group. Usernames and passwords were created for the patients in this group to log in, and information about the drugs (drug name, frequency of administration) was recorded. The mobile application was introduced to the patients informed about receiving online data. Patients can access information about AS and anti-TNF drug administration and management anytime. The data entries saved in the mobile application by the patients were checked by the researcher using the patient monitoring panel. Patients who did not enter data were sent warning messages via the monitoring panel.
- Patients in the booklet group were given an education booklet, the written version of the mobile Android application. They were asked to refer to this booklet during their next treatment, measure and record their body temperature, and take medication if it was below 37.5 ºC.
- Patients in both groups were evaluated using the BASDAI, BASFI, ASQoL, and the SC Anti-TNF Treatment Questionnaire once every six weeks for six months in accordance with the expert opinion of the rheumatologist.

Outcomes and Measurement

The primary outcomes of this study were patients' opinions of the SC Anti-TNF Drug Questionnaire.

The secondary outcomes of this study were patients' BASDAI, BASFI, and ASQoL scores. Data were collected using the Individual Identification Form, BASDAI, BASFI, ASQoL, Subcutaneous Anti-TNF-α Treatment Questionnaire, and DISCERN Instrument (Quality of Criteria for Consumer Health Information).

***Individual Identification Form*:** The researchers developed this form, which consisted of 13 questions about the patient's diagnosis, age, gender, marital status, educational status, habits, and treatment plan.

BASDAI, BASFI, and ASQoL: *Turkish version of BASDAI*[20]*, BASFI*[21]*,* and *ASQoL*[22] were used. *BASDAI* consists of six questions about fatigue, spinal pain, joint swelling, joint tenderness, and morning stiffness, to evaluate disease activity in the past week.[20] *BASFI* consists of 10 questions: eight are about activities of daily living, and two are about coping with life. Each question is scored from 0 to 10 points.[21] *ASQoL* consists of 18 questions with two options, “Yes” / “No,” scored ‘‘1’’ and ‘‘0,’’ respectively. Total scores range from 0 to 18. with a higher score indicating poor quality of life.[22]

***Subcutaneous Anti-TNF-α Treatment Questionnaire*:** The researchers created this to evaluate the treatment status of patients using an anti-TNF drug. A semi-structured interview form was created by the researchers, which included drug information, storage conditions, dose skipping/forgetting, patient injection practices, difficulties encountered during drug administration, and side effects.[18,19] Semi-structured interview forms were filled out in 45-60 minutes through in-depth interviews with 10 patients not included in the sample. An item pool containing 30 questions was created. 5 experts evaluated the appropriateness of each statement in the created item pool. After the experts’ opinions, the necessary revisions were made, and a 25-item questionnaire was created. The opinions of five experts were obtained to evaluate the questions, and the content validity index was calculated. The questionnaire was applied and tested with 5 patients with the same characteristics as the sample group. These 5 patients were not included in the study. The experts' answers to the Subcutaneous Anti-TNF Treatment Questionnaire were evaluated using the content validity formula. The questionnaire's CVI (Content Validity Index) was calculated as 1. The CVI value was greater than 0.80, indicating that the questionnaire was statistically valid. [23]

***DISCERN Instrument*:** This instrument evaluates the quality and reliability of training materials providing information in the health field and consists of 16 questions. The first eight questions (1-8) measure the reliability of the information included in the material; the next seven questions (9-15) measure the quality of the information in the material. The last question (16) evaluates the material in general. [24]

Ethical considerations

Ethics committee approval was obtained from Eskişehir Osmangazi University Clinical Research Ethics Committee

before the study (date: 27.09.2017, number: 80558721/261). Written permission was obtained from the relevant institution where the study was conducted. All patients were informed about the study, and their written informed consent was obtained. The study was carried out in accordance with the Declaration of Helsinki.

Statistical Analysis

The data were analyzed in the IBM SPSS Statistics V 21.0 (IBM SPSS Corp., Armonk, NY, USA) package program. The Shapiro-Wilk test was used to test the suitability of quantitative variables to the normal distribution. Quantitative variables with normal distribution were presented as mean±standard deviation and mean±standard error; those that did not fit normal distribution were presented as median and quartiles (Q1-Q3). The intergroup distribution of quantitative variables that showed normal distribution was compared using the t-test, and the distribution of those that did not show normal distribution was compared using the Mann-Whitney U test. Distributions of repeated measurements according to the groups were evaluated using a two-factor analysis of variance with a one-factor repeated measure. Summary values of qualitative variables were shown using frequency and percentage. The correlation between qualitative variables was tested using Pearson's Exact Chi-squared test and Fisher's Exact Chi-squared test. Expert opinions on the content of the mobile Android application were evaluated using Kendall's W to determine the degree of concordance.

RESULTS

The study included 34 patients who met the sampling criteria out of 90 patients who received SC anti-TNF treatment. Of the patients included in the sample and both groups, one was diagnosed with cancer, and the other had a skin reaction, and her treatment was terminated. Therefore, the study was completed with 32 patients (Figure 2).

DISCERN Instrument and Expert Opinions on the mobile application

When the written material for the mobile application was evaluated using the DISCERN instrument, the score obtained from the first 15 questions was 65.4±11.32 out of 75; the general score was 5.0±0 out of 5. The concordance coefficient of the five experts' opinions on the quality and reliability of the information provided in the mobile application was calculated as W:0.272, *P*=.130 (Supplement Table 1). The quality and reliability of the information in this mobile application developed for anti-TNF drug administration of AS patients were high, according to the experts, and this showed that patients could safely use the application.

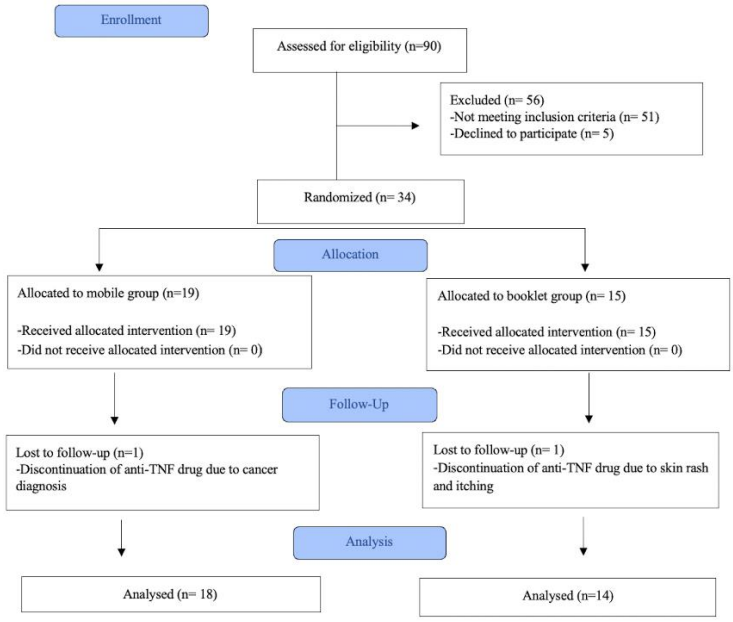

Figure 2. CONSORT flow chart of the research

Patients' sociodemographic, disease, and treatment characteristics

When the sociodemographic, disease, and treatment characteristics of the patients were compared, no statistical difference was found between the patients in both groups in terms of age, gender, marital status, educational status, employment status, drug prescribed, and presence of chronic disease, and the groups were similar (*P*>.05). The mean age of the patients in the mobile and booklet groups was 37.38±11.77 years and 41.78±16.03 years, respectively. The majority of the patients in both groups were male (75%), married (65%), and high school graduates (50%) who worked full-time (62.5%). The mean disease duration was 8.6±5.7 years in the mobile group and 12.9±12.6 years in the booklet group. Patients in the mobile group had received AS treatment for seven years, and patients in the booklet group had received treatment for three and a half years (Table 1).

Patients' subcutaneous anti-TNF drug administrations

Table 2 shows the patients' opinions of the SC Anti-TNF Drug Questionnaire at weeks six and 24, respectively. According to the SC Anti-TNF Drug Questionnaire, more patients in the booklet group had received help from someone else to administer the drug at weeks six and 24 (week 6: *P*=.003; week 24: *P*=.011) (Table 3). At week 24, four patients in the booklet group had not administered their drugs in the previous six weeks, thinking that their disease was under control (*P*=.028).

Table 1. Distribution of socio-demographic, disease and treatment characteristics of patients

Characteristics		Mobil group Mean±SD		Booklet group Mean±SD		t		*P*
Age (year)		37.38±11.77		41.78±16.03		-0.895		.378
Duration of disease (year)		8.6±5.7		12.9±12.6		-1.282		.210
		Median (Q1-Q3)		**Median (Q1-Q3)**		**Test***		***P***
Duration of treatment (year)		7.0(3.75-10.5)		3.5(0.9-17.0)		119.0		.808
						Total	χ^2	***P***
		n	**%**	**n**	**%**	**n** **%**		
Gender	Female	5	27.8	3	21.4	8 25.0	_[a]	1.000
	Male	13	72.2	11	78.6	24 75.0		
Marital status	Married	13	72.2	8	57.1	21 65.6	2.846[b]	.319
	Single	5	27.8	6	42.8	11 34.4		
Education level	Primary school	3	16.7	4	28.6	7 21.8	5.648[b]	.215
	Secondary school	2	11.1	0	0.0	2 6.3		
	High-school	11	61.1	5	35.7	16 50.0		
	Undergraduate	2	11.1	4	28.6	6 18.8		
	Postgraduate	0	0.0	1	7.1	1 3.1		
Employment status	Full time	12	66.7	8	57.1	20 62.5	1.413[b]	.706
	Part time	0	0.0	1	7.1	1 3.1		
	Unemployed	6	33.3	5	35.7	11 34.4		
Previous treatment	NSAIDs	18	100.0	14	100.0	30 93.8	_[a]	.492
	Anti-Rheumatic Drugs	18	100.0	11	78.5	29 90.6	_[a]	.073
	Immune regulatory drugs	8	44.4	7	50.0	15 46.8	_[a]	1.000
Prescribed Anti-TNF Drug	Etanercept (pen)	3	16.7	4	28.5	7 21.9	8.441[b]	.068
	Adalimumab (injector)	0	0.0	2	14.3	2 6.3		
	Adalimumab (pen)	1	5.5	3	21.4	4 12.5		
	Sertolizumab pegol (injector)	4	22.2	5	35.7	9 28.1		
	Golimumab (pen)	10	55.5	0	0.0	10 31.3		
Chronic disease**	Yes	3	17.7	5	35.7	8 25.0	_[a]	.252
	No	15	83.3	9	64.3	24 75.0		

*Mann-Whitney U Test, **Diabetes mellitus, Hypertension, Coronary Artery Disease, Asthma, SD; Standard Deviation, t; Independent Sample t-test, [a]Fisher's Exact Chi-Squared; [b]Pearson Exact Chi-Squared, χ^2; Chi-Squared Test

There was no regarding problems experienced during drug administration (*P*>.05). In general, patients were easily able to continue the SC anti-TNF drug treatment and were satisfied with the treatment at week six (*P*>.05) (Supplement Table 2); however, at week 24, the patients in the mobile group were more easily able to continue their treatment (*P*=.027) and were more satisfied with the treatment compared to the booklet group (*P*=.002,Table 2).

BASDAI, BASFI, and ASQoL score comparison

The mean BASDAI, BASFI, and ASQoL scores of the patients in both groups decreased by a statistically significant level (*P*<.001) in each evaluation from week 0 to week 24. The changes in the mean BASDAI and BASFI scores over time differed by groups (*P*=.025 and *P*=.037, respectively), and this difference resulted from the mean scores at week six (*P*=.007 and *P*<.001, respectively). When the mean BASDAI, BASFI, and ASQoL scores of the patients were examined, the mean scores of all three scales were found to be statistically significantly lower in the mobile group than in the booklet group (*P*<.05) (Table 3).

DISCUSSION

In our study, the DISCERN Instrument was used to evaluate the information quality and reliability of the mobile application. This measurement tool evaluates the relevance and quality of the information given about treatment.[24] DISCERN Instrument have been used previously to evaluate web-based health education and written materials online.[25,26] Maximum 75 points from 15 questions in the measurement tool; A maximum of 5 points is taken from the last question, which is evaluated separately from these, and the high scores indicate that the quality and reliability of the material is high.[24] Our written material for the mobile application score obtained from the first 15 questions was 65.4±11.32 out of 75; The general score was 5.0±0 out of 5. According to this result, the mobile application we developed for anti-TNF drug administration in AS patients has high information quality and reliability and can be used safely by patients.

Table 2. Comparison of some responses of patients regarding subcutaneous anti-TNF drug administration in the 24th week evaluation

Questions			Mobil group n	Booklet group n	Total	X^2	*P*
Anti-TNF drugs should be stored according to the cold chain rule		Yes	17	13	30	_[a]	1.000
		No	1	1	2		
Drug administration frequency		Once a week	3	4	7	0.766[b]	.813
		Once every two weeks	5	4	9		
		Once a month	10	6	16		
Did you inject your drug with a prefilled syringe or use an auto-injector (pen)?		Prefilled syringe	4	7	11	_[a]	.142
		Auto-injector	14	7	21		
How often was your drug administered by someone else?		I always administered it myself	14	5	19	7.999[b]	**.01**
		Administered several times by someone else	4	5	9		
		It was always administered by someone else	0	4	4		
Have you ever forgotten to take your drug or not taken on time in the last 6 weeks?		Yes	4	6	10	_[a]	.267
		No	14	8	22		
What factors were effective in forgetting to take your drug?	Memory problems	Yes	2	2	4	_[a]	1.000
		No	16	12	28		
	Busyness	Yes	2	3	5	_[a]	1.000
		No	16	11	27		
	Needle phobia	Yes	0	1	1	_[a]	1.000
		No	18	13	31		
	Drug side effect	Yes	0	2	2	_[a]	.183
		No	18	12	30		
	Anxiety	Yes	1	0	1	_[a]	1.000
		No	17	14	31		
Have you ever had to postpone your drug by consulting your doctor?		I never postponed	16	11	27	2.803[b]	.423
		Postponed due to flu infection	2	1	3		
		Postponed due to fatigue	0	1	1		
		Other*	0	1	1		
Have you ever preferred not to take your drug, considering that your disease is under control?		Yes	0	4	4	_[a]	**.028**
		No	18	10	28		
Have you ever experienced bleeding in the injection area while taking your drug?		Never	10	5	15	1.524[b]	.508
		Sometimes	7	7	14		
		Mostly	1	2	3		
Have you ever experienced pain, stinging, burning, or pain in the injection area while taking your drug?		Never	9	9	18	4.571[b]	.161
		Sometimes	9	3	12		
		Mostly	0	1	1		
		Always	0	1	1		
Have you ever experienced itching or irritation in the injection area while taking your drug?		Never	18	11	29	_[a]	.073
		Sometimes	0	3	3		
Have you ever felt frustrated or anxious while taking your drug?		Never	16	10	26	_[a]	.365
		Sometimes	2	4	6		
Have you ever experienced swelling, stiffness, or lump in the injection area after taking your drug?		Never	17	13	30	_[a]	1.000
		Sometimes	1	1	2		
Have you ever experienced any abnormal redness or rash in the injection area after taking your drug?		Never	18	12	30	_[a]	.183
		Sometimes	0	2	2		
Have you ever experienced bruising in the injection area after taking your drug?		Never	13	9	22	_[a]	.712
		Sometimes	5	5	10		
			Median (Q1-Q3)	**Median (Q1-Q3)**	**Test****		***P***
Overall difficulty level in continuing SC anti-TNF drug treatment			0(0-2)	2(1-4)	70.00		**.027**
Satisfaction level with anti-TNF drug treatment in the last 6 weeks			10(9-10)	8(5-10)	51.00		**.002**

*Prescription problem, ** Mann-Whitney U Test, X^2; Chi-squared, [a]Fisher's Exact Ki-kare; [b]Pearson Exact Ki-kare

Table 3. Comparison of the distribution of patients' BASDAI, BASFI and ASQoL scales score

Scales		Mobil group		Booklet group		*P**		
		Mean	Standard error	Mean	Standard error	Time	Group	Time X group
BASDAI	0th week	5.7	0.36	5.8	0.41	**<.001**	**.040**	**.025[a]**
	6th week	1.8	0.41	3.8	0.46			
	12th week	1.7	0.30	2.5	0.34			
	18th week	1.6	0.34	2.1	0.39			
	24th week	1.2	0.19	1.5	0.21			
	[a]6th week (*P*=.003)							
BASFI	0th week	4.9	0.60	4.9	0.68	**<.001**	**.033**	**.037[b]**
	6th week	1.0	0.34	3.1	0.39			
	12th week	0.6	0.22	1.2	0.24			
	18th week	0.5	0.22	0.6	0.25			
	24th week	0.2	0.10	0.5	0.12			
	[b]6th week (*P*<.001)							
ASQoL	0th week	10.7	1.02	9.7	1.16	**<.001**	**.037[c]**	.076
	6th week	1.5	0.87	4.6	0.98			
	12th week	0.05	0.38	1.8	0.43			
	18th week	0.5	0.44	1.7	0.5			
	24th week	0.06	0.21	1.0	0.24			
	[c]ASQoL score mean	2.5±0.38		3.8±0.43				

BASDAI; Bath Ankylosing Spondylitis Disease Activity Index, BASFI; Bath Ankylosing Spondylitis Functional Index, ASQoL; Ankylosing Spondylitis Quality of Life Scale; *Two-way repeated measures ANOVA for one factor, [a, b]Statistical significance of the mean score differences of scales at the 6th week, [c]Statistical significance of the mean scores differences of ASQoL in between groups

In the study in which internet-based information for individuals with Raynaud phenomenon and patients with systemic sclerosis were evaluated with DISCERN Instrument, the general score for both diseases was determined to be 1.0 (1.0-5.0), contrary to the score of our mobile application material.[25] In another study, it was observed that the DISCERN Instrument scores of web-based training developed for patients diagnosed with lung cancer were similar to the results of our study.[26]

In our study, fewer patients in both groups forgot or missed their medication in the 6th week compared to the 24th week (Supplement Table 2 and Table 2). This may be because patients feel hope and excitement about a new treatment and adhere to their treatment program. This may also be associated with the fact that the researcher applied the treatment to both groups at the beginning of the study and gave training on the topic to the patients. However, in the evaluation's 24th week, four patients in the mobile application group had forgotten to take their drugs or had missed taking them five times. In comparison, six booklet group patients had forgotten or missed taking them 12 times. Patients in the booklet group stated that they did not administer their drugs because they forgot or were too busy, that they had a phobia of needles, and that there were side effects from the injection. In contrast, patients in the mobile application group stated that they did not administer their drugs because they forgot, were busy, had side effects from the injection, or had a phobia of needles. It has been stated that patients can skip drug doses in SC treatment due to fear, pains, and aches,[6,9] difficulty in preparing the injection[10], feeling bad after the injection[9], embarrasment[9,10], patient lack of confidence, and incorrect administration.[11] For these reasons, it is recommended that nurses consider these issues when training patients who self-administered their SC drug and include these points in the training.

At the 24th week evaluation, significantly more patients in the booklet group had not administered their drugs in the previous six weeks, thinking that their disease was under control (*P*=.028). Nurse-led interventions that include patient training, counseling, motivational interview-based medication adherence therapy, and reminders to take drugs affect the use of drugs regularly, health outcomes, functionality, hospitalization, and quality of life positively.[27] Telehealth support interventions are recommended to improve medication adherence, reduce health expenses and healthcare utilization, and improve self-care and health outcomes.[28] Özkaraman et al.[29] found that training provided by the nurse and telephone follow-ups were effective in adhering to the treatment of patients who had a rheumatological disease and who used an SC anti-TNF drug. Mobile group patients in our study receive reminder messages and have 24-hour access to notifications about side effects, information about the disease, and guides and relevant diagrams about administering SC drugs, which may be effective for them in administering their drugs more regularly. Furthermore, Barello et al. [30] stated that a nurse-led, telephone-based patient support program improved perceived self-care skills, emotional coping for

the future, the unpredictability of the course of the disease, and general attitudes toward the injection itself, involving pain tolerance of multiple sclerosis patients receiving interferon-alpha therapy. In line with these results, it is recommended that nurses provide AS patients with information about their medications (effects of the drug, side effects, storage conditions, waste removal) and how to prepare and administer them and that they evaluate and consult with patients intermittently to improve drug administration easily and improve the health outcomes of those using SC anti-TNF drugs.

Today, the number of mobile applications available has increased alongside smartphones. However, there is only a limited number of mobile applications developed for AS patients with information about the disease,[16,17] medication, exercise, daily life management, how to assess disease activity function, and reminders to take their medication[17] and it is noteworthy that there has been no prior study examining SC anti-TNF drug administration and management among AS patients. Domanska et al.[15] stated that the mobile application they developed for rheumatoid arthritis patients using certolizumab pegol, which supports them throughout their disease, helps patients better manage their treatment and disease. Similarly, Song et al.[17] showed that the HBM-based educational intervention through mobile application improved patient disease knowledge and self-efficacy. In our study, the rate of self-administration was determined to be higher among the patients in the mobile group and lower in the booklet group. This may be due to the feedback given to the patients through the mobile application for solutions to the problems encountered while administering SC anti-TNF drugs.

In the 24th week of the evaluation of our study, the patients in the mobile group could more easily continue their treatment. They were more satisfied with the treatment than the booklet group. This result can be explained as being due to the patients receiving reminder messages and having 24-hour access to notifications about side effects, information about the disease, and guides and relevant diagrams about administering SC drugs. In addition, the number of patients who administered drugs with an auto-injector was higher in the mobile group. Roszkiewicz et al.[31] reported that patients administered subcutaneous injection with an auto-injector device more easily than with a prefilled syringe showed a high degree of satisfaction experiencing the self-injection with auto-injector and had less pain and fewer problems when using an auto-injector. It is stated that drugs in the form of autoinjectors are more valuable for rheumatoid arthritis patients to improve their injection experience by reducing their fear and anxiety and overcoming difficulties arising from dexterity problems.[7] Ghil et al.[32] explained in their study that patients with rheumatoid arthritis prefer adalimumab, an autoinjector, over a prefilled syringe. Likewise, while more than half of the patients in the mobile group used golimumab, none of the patients in the booklet group used golimumab in this study. Like other self-administered TNF inhibitors, Golimumab is administered monthly rather than weekly or biweekly. It is thought that the fact that golimumab has a monthly dosing schedule affects the fact that patients using this drug make the injection more easily and have a higher rate of treatment adherence. Therefore, to eliminate this factor, it is recommended that the sample group be divided according to the use of auto-injectors in subsequent studies. In addition, the healthcare team needs to consider the patient's preference when deciding on SC anti-TNF drug therapy, as the injection type facilitates adherence to treatment, which will lead to positive health outcomes and an increase in the patient's quality of life.

Anti-TNF drugs are an effective treatment option for AS patients and are used to reduce symptoms, slow down the radiological progression, and improve physical function. Decreased BASDAI and BASFI scores in AS patients indicate a remission in disease activity and improved physical function. Regularly monitoring AS patients using an anti-TNF is important in managing AS.[33] Initially, the patients in our study had high disease activity and moderate physical function. Similar to the literature, patients' BASDAI and BASFI scores had decreased significantly at the six-month follow-up.[34] This decrease was higher in the patients in the mobile group than in the booklet group ($P<.005$). Within the scope of the study, while the patients in the booklet group were informed once at the beginning of the treatment about the disease, anti-TNF treatment, healthy lifestyle behaviors, and situations to be paid attention to verbally and written; this information was presented constantly with the mobile device in the mobile group. Therefore, the mobile application informs patients about anti-TNF treatment, healthy lifestyle behaviors, and important points in daily care, thus ensuring that patients' motivation is high. It is predicted that this may effectively decrease the disease activity in patients.

Structural disorders in the spine and their symptoms lead to difficulties with daily living activities and a significant decrease in the quality of life of AS patients. Disease activity and functioning are among the strongest determinants of quality of life. Quality of life decreases as disease activity and functional loss increase.[34] Youssef and Rafey et al.[35] reported a significant decrease in mean ASQoL scores of AS patients six and 12 months after starting anti-TNF drug treatment. Likewise, in our study, the mean ASQoL scores

of patients in both groups had decreased at the end of the sixth month using anti-TNF drugs. Moreover, in our study, the mean ASQoL score was generally higher in the booklet group than in the mobile group (*P*=.037). This shows that the quality of life of the patients in the mobile group was higher than that of the patients in the booklet group. This can be explained by the fact that the decrease in disease activity and greater improvement in functional capacity positively affected patients' quality of life in the mobile group.

Strengths and Limitations of the study

The strengths of this study are that it is the first mobile application for SC anti-TNF drug administration in AS patients, that AS patients have a training material where they can access quality and reliable information about drug administration remotely, and that the healthcare team can follow them up during the treatment process. Despite that, this study has a limitation. Since the budget for the development of the mobile application was limited, only those whose smartphones ran on Android, the most popular operating system in Turkey, were included in the study. Smartphone users with the IOS operating system could thus not be included.

This study determined that the mobile application developed for SC anti-TNF therapy in AS patients has high information quality and reliability and facilitates the administration of SC anti-TNF drugs. For this reason, it is recommended that written and visual materials support the mobile application to facilitate the application of SC anti-TNF to patients who will self-administer SC anti-TNF at home.

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Hakem Değerlendirmesi: Dış bağımsız.
Yazar Katkıları: Fikir- FU, AÖ, CK; Tasarım- FU,AÖ,CK; Denetleme- AÖ,CK; Kaynaklar- FU,AÖ,CK; Veri Toplanması ve/veya İşlemesi FU; Analiz ve/ veya Yorum- FU,AÖ; Literatür Taraması- FU,AÖ; Yazıyı Yazan- FU,AÖ; Eleştirel İnceleme- FU,AÖ,CK
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Supplement Table 1. Distribution of mean scores of the information quality and reliability of the mobile training material

Discern Measurement Tool Question Items		**Mean ± SD**
1	Is its objective clear?	4.8±0.44
2	Are the objectives achievable?	4.8±0.44
3	Is it relevant to the subject?	4.8±0.44
4	Are the resources stated clearly?	5.0±0
5	Is the date of the reported or used information stated clearly?	4.8±0.44
6	Is it impartial and consistent?	4.8±0.44
7	Does it provide details on additional information or supportive resources?	4.0±1.73
8	Are uncertain aspects mentioned?	2.6±2.19
9	Does it describe how each treatment is administered?	5.0±0
10	Does it describe the benefits of each treatment?	4.2±0.83
11	Does it describe the risks of each treatment?	4.2±0.83
12	Does it describe what will happen in the absence of treatment?	4.0±1.73
13	Does it describe how treatment options affect the quality of life?	4.2±1.78
14	Has the possibility of the presence of more than one treatment option been explained?	4.2±1.78
15	Does it provide support for the patient in making decisions?	4.0±1.73
16	General evaluation	5.0±0

	n	**Mean ± SD**	**Minimum**	**Maximum**	**Kendall's W**	***P***
Information quality	5	35.6±4.03	31	40	**0. 272**	**0.130**
Information reliability	5	29.8±8.43	15	35		
Total	5	65.4±11.32	47	74		

SD; Standart deviation

Supplement Table 2. Comparison of some responses of patients regarding subcutaneous anti-TNF drug administration in the 6th week evaluation

Questionnaire Questions			Mobil application group	Booklet group			
			n	n	Total	χ2	*P*
Anti-TNF drugs should be stored according to the cold chain rule		Yes	18	13	31	_[a]	.437
		No	0	1	1		
Drug administration frequence		Once a week	3	4	7	0.766[b]	.813
		Once every two weeks	5	4	9		
		Once a month	10	6	16		
Did you inject your drug with a prefilled syringe or use an auto-injector (pen)?		Prefilled syringe	4	7	11	_[a]	.142
		Auto-injector	14	7	21		
How often was your drug administered by someone else?		I always administered it myself	15	4	19	11.041[b]	**.003**
		Administered several times by someone else	3	6	9		
		It was always administered by someone else	0	4	4		
Have you ever forgotten to take your drug or not taken on time in the last 6 weeks?		Yes	2	4	6	_[a]	.365
		No	16	10	26		
What factors were effective in forgetting to take your drug?	Memory problems	Yes	2	2	4	_[a]	1.000
		No	16	12	28		
	Busyness	Yes	0	1	1	_[a]	.437
		No	18	13	31		
	Needle phobia	Yes	0	2	2	_[a]	.183
		No	18	12	30		
Have you ever had to postpone your drug by consulting your doctor?		I never postponed	16	12	28	1.427[b]	.762
		Postponed due to flu infection	2	1	3		
		Other*	0	1	1		
Have you ever preferred not to take your drug considering that your disease is under control?		Yes	0	2	2	_[a]	.183
		No	18	12	30		
Have you ever experienced bleeding in the injection area while taking your drug?		Never	9	6	15	0.730[b]	.768
		Sometimes	8	6	14		
		Mostly	1	2	3		
Have you ever experienced pain. stinging. burning or pain in the injection area while taking your drug?		Never	8	7	15	3.285[b]	.285
		Sometimes	10	5	15		
		Always	0	2	2		
Have you ever experienced itching or irritation in the injection area while taking your drug?		Never	18	13	31	_[a]	.437
		Sometimes	0	1	1		
Have you ever felt frustrated or anxious while taking your drug?		Never	17	9	26	_[a]	.064
		Sometimes	1	5	6		
Have you ever experienced swelling. stiffness or lump in the injection area after taking your drug?		Never	17	14	31	_[a]	1.000
		Sometimes	1	0	1		
Have you ever experienced any abnormal redness or rash in the injection area after taking your drug?		Never	18	12	30	_[a]	.183
		Sometimes	0	2	2		
Have you ever experienced bruising in the injection area after taking your drug?		Never	11	9	20	_[a]	1.000
		Sometimes	7	5	12		
			Median (Q1-Q3)	**Median (Q1-Q3)**	**Test****		***P***
Overall difficulty level in continuing subcutaneous anti-TNF drug treatment			1.5(0-3)	4(2-6)	80.00		.074
Satisfaction level with anti-TNF drug treatment in the last 6 weeks			9(8-10)	8.5(4-10)	98.5		.280

[a]Fisher's Exact Ki-kare, [b]Pearson Exact Ki-kare, *Prescription Problems, **Mann-Whitney Test