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RESEARCH ARTICLE

The Effect of Kinesiological Taping on Pain, Function, and Disability in Subacromial Impingement Syndrome - A Randomized Controlled Study

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Abstract
Objective: Subacromial Impingement Syndrome (SIS) is one of the most common shoulder pathologies that cause pain and lose of function. This study aimed to compare the effects of kinesiological taping and conventional physiotherapy (CP) on pain, functionality, and disability in SIS patients.
Materials and Methods: The study was completed with 54 patients aged 18-60 years. By randomization, the participants were divided into two groups: The Intervention Group (IG) and the Control Group (CG). While the CP was performed for ten sessions, kinesiological taping was repeated every three days for the IG. The CG was taken to only ten sessions of CP. The CP was applied for 60x5x2 minutes/day/week. Pain severity, function, and disability were assessed before and after the treatment.
Results: There was no difference between the groups in pain severity (p=0.074), function (p=0.565), and disability (p=0.315) scores. On the other hand, there were significant improvements in pain (p=0.001), function (p=0.001), and disability (p=0.005) scores of IG according to intra-group analysis. Similar results were obtained in the CG. However, when the effect sizes of these treatment methods were examined, they did not create a clinically significant superiority compared to each other.
Conclusion: Kinesiological taping has been widely used in patients with orthopedic problems. According to our results, kinesiological taping did not have a clinical effect in reducing pain, improving function and disability when applied with CP compared to CP alone. We think that only kinesiological taping may not be sufficient be an alternative to traditional methods in the early term.

Keywords
Subacromial Impingement Syndrome, Taping, Pain, Function, Disability

INTRODUCTION

Subacromial Impingement Syndrome (SIS) is one of the most common shoulder pathologies that causes pain and dysfunction (Östör, Richards, Prevost, Speed, & Hazleman, 2005). Although the exact etiology is unknown, biomechanical factors that increase the compression force in the subacromial arch are generally emphasized (Turgut, Duzgun, & Baltaci, 2017). Especially the tension of the structures in the posterior shoulder region causes the humeral head to slide both forward and upward in the glenoid fossa, reducing the subacromial space and increasing the compression force on the structures in this region (McClure et al., 2007). The pathophysiological process resulting from increased compression force on anatomical structures and repetitive functional activities causes functional limitations by triggering pain and restriction of movement (Kromer, De Bie, & Bastiaenen, 2010).

Different conventional treatment modalities such as transcutaneous electrical nerve stimulation (TENS), cryotherapy, ultrasound, and exercise are used in the standard treatment of SIS in clinics (Juárez-Albuixech et al., 2021). While

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electrophysiological agents aim to affect the pain and inflammation process directly, the primary purpose of exercise programs is to control the pain and inflammation process by providing biomechanical alignment (Macías-Hernández & Pérez-Ramírez, 2015). In particular, exercise programs are the cornerstone of the treatment plan for pain control and disability relief (Turgut et al., 2017). Exercise programs include scapular stabilization, strengthening of the rotator cuff muscles, range of motion, and stretching exercises (Ravichandran et al., 2020). Studies show that satisfactory results can be obtained in 70-90% of patients after conservative treatment of SIS (Consigliere, Haddo, Levy, & Sforza, 2018). In addition to exercise and electrophysical modalities, another method is taping techniques commonly used in clinics (Şimşek, Balki, Keklik, Ozturk, & Elden, 2013).

Kinesiological taping aims to reduce pain with neural connections, increase their function by supporting weak muscles, and reduce muscle spasms by repositioning the joint (Artioli & Bertolini, 2014). Kinesiological taping helps pain control by reducing inflammation and edema, activating the gate control system and descending inhibitory mechanisms with sensory stimuli, and regulating superficial and deep fascia functions. Therefore, the study's primary aim is to examine the effect of kinesiology taping on pain in patients with SIS. The second goal is to investigate out what effect taping has on disability and functional status.

MATERIALS AND METHODS

Study design and blinding

The randomized controlled study was completed with 54 patients aged 18-65 and the study universe consisted of individuals residing in Istanbul diagnosed with SIS. Before the treatment program and at the end of the 10-session rehabilitation program, the patients were evaluated.

The online randomization software (www.randomizer.org) was used for group distributions, and the patients were divided into two groups: the Implementation Group (IG) and the Control Group (CG). In group CG, only the conventional physiotherapy program (CPP) was applied, but in group IG, the CPP was used along with kinesiology taping.

Due to the nature of the study, blinding could not be done in the treatment practices. All physiotherapy applications were performed by the same physiotherapist.

Participants

The inclusion criteria were (1) having been diagnosed with Type I-II impingement (2) being between the ages of 18-65, and (3) having had no steroid injections in the shoulder region in the last 6 months. The exclusion criteria were: (1) the presence of previous shoulder surgery, (2) neurological and rheumatic disease, (3) Type-1 diabetes, (4) the presence of other orthopedic pathology in the shoulder region, (5) malignancy.

The Medipol University Ethics Committee approved the study with decision number 228. Written informed consent was obtained from all patients and the study was conducted under the Helsinki Declaration.

Interventions

- Conventional physiotherapy protocol (CPP)

All of the patients received CPP five times a week for two weeks, and each session lasted about 60 minutes.

Hot Pack: Hot packs filled with silicon dioxide and kept in special boilers at 65-90ºC were used for 20 minutes to increase local circulation. It was aimed at relaxing the muscles and decreasing the pain with hot pack application.

Transcutaneous Electrical Nerve Stimulation (TENS)

The conventional mode of TENS was used in the study for decreasing the pain. This mode frequency is 60-120 cycles/sec, and the current transition time is 50-100 μsec. The treatment time was applied as 20 minutes.

Ultrasound

Ultrasound was applied to the affected shoulder in a continuous mode at a dose of 1.2-1.5 W/cm2, with full contact technique and at right angles to the rotator cuff area for two weeks, five days a week, five minutes a day. It was aimed at reducing pain, increasing metabolism and using micromassage effects with ultrasound therapy.

Exercises: Codman exercises, pectoral muscle and posterior capsule stretching, wall push-ups, isoflex band exercises were performed under the supervision of a physiotherapist. The exercises were performed from simple to complex during the treatment, taking into account the patient's clinical condition.

Kinesiological taping protocol:

The taping application was performed by a physiotherapist with more than 15 years of clinical experience and trained in kinesiology taping, with more than 5 years of experience.

A 5 cm tape (Ares Kinesiology TAPE) was used for kinesiological taping. Taping was repeated every three days during the entire treatment period. Tapings to the deltoid, supraspinatus, and teres minor muscles were used with the insertio-origo muscle technique. The beginning of the strips was applied to the deltoid and supraspinatus without tension. Taping was performed for all three muscles with a tension of approximately 15-25% on the body of the bands.

The beginning of the Y strip used for taping for the deltoid was glued 3 cm below the tuberositas deltoidea of the humerus. The posterior end of the Y tape was placed on the pars spinalis of the spina scapula while the arm was at 45° flexion, horizontal adduction, and internal rotation. Then, the shoulder was placed in external rotation and hyperextension to place the anterior tail of the band. The lower end of the tape was adhered to the 1/3 lateral of the clavicle without stretching (Figure 1).

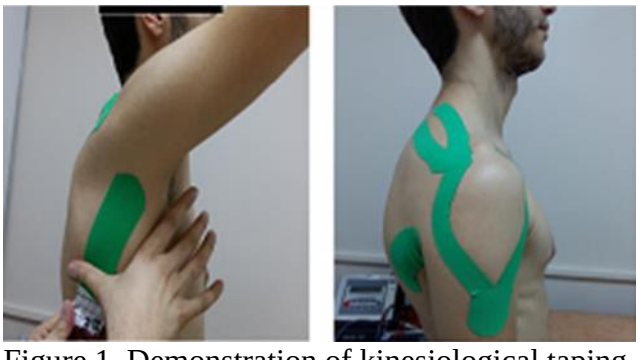

Figure 1. Demonstration of kinesiological taping

To provide Y strip tissue tension for the supraspinatus muscle, the shoulder was placed in extension, adduction, and internal rotation, and the head and neck were lateral flexed to the opposite side. Starting 3 cm below the tuberculum majus, taping was performed towards the fossa supraspinata.

The shoulder was placed in an abduction and internal rotation position for the tapping of the teres minor muscle. Then, approximately 15 cm of tape was applied as an I strip. The application site started from the lower part of the greater tuberculum and ended at the margo lateralis of the scapula.

No adverse events occurred during all treatment.

Assessments

Demographic data form

The demographic and social characteristics of the individuals (age, height, weight, gender, educational status, dominant extremity, presence of trauma, stage of pathology) were questioned in the assessment form.

Visual analog scale (VAS)

This scale is the most commonly used scale to describe the severity of pain. Patients are asked to mark the paint severity on a 10 cm line on the scale. 0 represents no pain, and 10 illustrates unbearable pain (Bijur, Silver, & Gallagher, 2001). In this study, rest, activity, and night pain were questioned separately.

Quick Disabilities of the Arm, Shoulder and Hand (Quick-DASH)

This is a self-administered questionnaire for patients with upper extremity pathology. The questionnaire shows the pain and functional status of the patients during activities of daily living, and its Turkish validity and reliability have been proven (Düger et al., 2006). The first part of Quick-DASH consists of 11 questions and the scoring is 5-point Likert type. The scoring for each section is between 0-100. A high score indicates high disability.

Shoulder Disability Questionnaire (SDQ)

The score is a 16-item disability questionnaire used in patients with shoulder problems. Based on the last twenty-four hours, patients answer each item in the questionnaire as yes, no, or not applicable. 0 points indicates maximum well-being and 100 points indicates the worst issue (Ozsahin, Akgun, Aktas, & Kurtais, 2008).

Statistical analysis:

The Statistical Package for Social Science (SPSS) 21.0 software package program was used to analyze the data obtained from the study. The normal distribution was determined by Shapiro Wilks and histogram curves. The mean, standard deviation, and percentage were used to express data from parametric variables. While the Independent Sample T-Test was used in the group comparisons, the Paired Sample T-Test was used for intra-group analysis. Statistical significance was accepted as $p<0.05$ in all analyses.

The power of the study was calculated using G*Power 3.1.9.1 software (Faul, Erdfelder, Lang,

& Buchner, 2007). The VAS score of the IG was context, Cohen's effect size was calculated as 1.12. When the alpha error was accepted as 5%, the power of the study was 80% and the allocation ratio of the groups was 1.16, the post-hoc power of the study was 83.15%.

RESULTS

Fifty-four patients included in the single-center study were randomly divided into two groups. There was no difference between the groups in terms of gender distribution (p=0.983), educational status (p=0.151), dominant extremity (p=0.530), presence of trauma (p=0.172), disease stage (p=0.343) and demographic characteristics with categorical variables at baseline. Apart from this, the mean age of the IG was 51.36±7.64 years, while it was 44.20±10.63 years in the CG (p=0.007). The mean body mass index (BMI) of the groups was similar (p=0.411). Demographics are shown in Table 1.

Table 1. Comparison of the demographic characteristics of the participants

Variables	Groups		*p*
	IG	CG	
Gender, *n (%)*			
Female	12 (48.00)	14 (48.00)	0,983[a]
Male	13 (52.00)	15 (52.00)	
Educational Status, *n (%)*			
Uneducated	2 (8.00)	4 (13.80)	
Primary Scholl	14 (56.00)	15 (52.00)	
High School	6 (24.00)	6 (21.00)	0,608[a]
Bachelor Degree	2 (8.00)	3 (10.00)	
Master's Degree	1 (4.00)	1 (3.00)	
Dominant Extremity, *n (%)*			
Right	23 (92.00)	28 (97.00)	0,530[a]
Left	2 (8.00)	1 (3.00)	
Having Trauma, *n (%)*			
Yes	10 (40.00)	17 (59.00)	0,172[a]
No	15 (60.00)	12 (41.00)	
Stage, *n (%)*			
I	6 (24.00)	8 (28.00)	0,343[a]
II	19 (76.00)	21 (72.00)	
	Mean (SD)	**Ort (SD)**	
Age (years)	51.36 ± 7.64	44.20 ± 10.63	0.007
BMI (kg/cm^2)	26.36 ± 4.71	27.56 ± 5.77	0.411

[a]: Fisher'ın Exact Chi Square Test; SD: Standard Deviation; IG: Intervention Group; CG: Control Group; BMI: Body Mass Index

The VAS score was used to assess the severity of pain before and after treatment. Baseline values for night pain (p=0.124), movement pain (p=0.508) and rest pain (p=0.270) were similar between the groups. After the treatment programs, a statistically significant decrease was observed in all the pain scores of both groups according to intra-group analysis (p<0.05) but no superiority over each other in reducing pain intensity (p>0.05) (Table 2).

The results for Quick-DASH scores were similar to the VAS score. According to the results of the inter-group analysis; While Quick-DASH scores of both groups were similar before treatment (p=0.919) and after treatment (p=0.565), significant improvements were observed in Quick-DASH scores of both groups in intragroup analyzes (p<0.05 for both) (Table 2).

The SDQ was used to assess shoulder disability. Accordingly, no significant difference between the groups in the pre-treatment (p=0.655) and post-treatment (p=0.315) SDQ scores were found. However, improvements were observed in the SDQ scores in the IG (p=0.001) and the CG (p=0.001) (Table 2).

Table 2. Comparison of pain, function, and disability status between the groups

Variables	Timeline	Groups		p[a]	ES (*d*)
		IG	CG		
Pain-Night	**T_0**	5.28 ± 3.18	6.69 ± 3.40	0.124	0.03
	T_1	2.32 ± 2.23	3.62 ± 2.90	0.074	
	p[b]	0.001	0.001	-	-
Pain-Movement	**T_0**	7.72 ± 2.03	8.07 ± 1.81	0.508	0.18
	T_1	4.36 ± 2.21	5.14 ± 2.47	0.232	
	p[b]	0.001	0.001	-	-
Pain-Rest	**T_0**	2.96 ± 3.29	3.97 ± 3.31	0.270	0.17
	T_1	1.08 ± 1.75	2.45 ± 2.78	0.330	
	p[b]	0.005	0.031	-	-
Quick-DASH	**T_0**	51.26 ± 14.65	51.79 ± 23.09	0.919	0.13
	T_1	33.08 ± 16.21	36.35 ± 24.79	0.565	
	p[b]	0.001	0.001	-	-
SDQ	**T_0**	76.41 ± 18.44	74.16 ± 18.24	0.655	0.44
	T_1	51.60 ± 25.73	59.17 ± 28.70	0.315	
	p[b]	0.001	0.001	-	-

[a]: Independent Sample T-test; [b]: Paired Sample T-test; ES: Effect Size; IG: Intervention Group; CG: Control Group; Quick-DASH: Quick-Disabilities of the Arm, Shoulder and Hand; SDQ: Shoulder Disability Questionnaire; T_0: First Assessment; T_1: Second Assessment

DISCUSSION

This study investigated the effects of kinesiological taping on pain, function, and disability in patients with SIS. A 10-session CPP was applied to all patients for this aim and every sessions consisted of 60 minutes. In addition, the kinesiological taping that renewed every three days was performed to IG. The most important result of the study is that either kinesiological taping applied in addition to the CPP or conventional physiotherapy reduces the pain intensity of the patients at night, during activity and rest. However, this decrease did not indicate the clinical superiority of the treatment programs compared to each other. According to the different study results, although there was a decrease in both groups' Quick-DASH and SDQ scores, no difference was detected between the groups. When the effect sizes were examined, it was seen that both programs did not create clinical superiority over each other.

The rehabilitation process in SIS patients is mainly maintained with conventional techniques using electrophysiological agents and exercise programs, which are the gold standard (Calis, Berberoglu, & Calis, 2011; Kuhn, 2009). TENS and US, which are the most commonly used electrophysiological agents, and an exercise program were applied to all patients in this study. It is known that ultrasound is used as a pain reliever just like TENS in the treatment of SIS and has positive effects on activities of daily living (Akin, Caglar, Burnaz, & Kesmezacar, 2013). In addition, it was reported that the exercise program effectively reduced pain (Celik, Akyuz, & Yeldan, 2009). For this reason, the CPP of our study consisted of electrophysiological agents and exercise programs. Six of the eleven articles in a systematic review examined the effect of exercise on pain, and five of these studies reported that exercise reduced the pain of patients with SIS (Kuhn, 2009). In the same review, it was reported that exercise also increases functional capacity.
Dilek et al. also observed that the traditional physiotherapy program, which they applied three days a week for six weeks, caused a decrease in the severity of pain in SIS patients (Dilek et al., 2016). Çelik et al. also stated that there is a relationship between shoulder girdle muscle weakness and pain parameter in patients with a diagnosis of SIS (Çelik, Sirmen, & Demirhan, 2011).

In the same study, it was emphasized that SIS might occur due to muscle weakness and muscle weakness may occur due to reflex inhibition. For this reason, strengthening exercises for the shoulder girdle and upper thoracic region constitute one of the most essential pillars of the rehabilitation process. In our results, both treatment methods caused a decrease in pain at night, movement, and rest. However, it was seen that kinesiological taping was not superior to conventional techniques in pain control. We think

that pain reduction in both groups is due to the effectiveness of electrophysiological agents and exercise modalities. TENS, one of the electrophysical agents, is the most widely used analgesic agent that provides pain control by using the gate control mechanism in physiotherapy clinics. Apart from this, improvements in patients' pain control may have been observed due to the thermal effects caused by the applied hot packs and continuous mode ultrasound therapy. In addition, supervised resistance exercises cause improvement in the soft tissues of the shoulder, and this situation increases the stabilization skills of the shoulder. In this way, the narrowing of the distance between the greater tubercle of the humerus and the acromion is prevented. This way, compression of the tendons is prevented and the shoulder moves in normal anatomical positions within the glenoid fossa. In addition, the shoulder girdle muscles wrap the area like a corset, resulting in increased stabilization. Apart from strengthening exercises, stretching exercises also play an essential role in relieving tension in the shoulder capsule and muscles and in reducing pain caused by pressure. We think that the direct effects of both electrophysiological agents and exercise programs on soft tissue may have positively shaped the results of our study.

Kinesiological tapes can maintain their elasticity for 3-7 days (Kase, Wallis, & Tsuyoshi, 2013). In the literature, it is possible to come across studies in which kinesiological bands are changed at different time intervals. For example, in the study of Akbaş et al., taping was repeated every four days, whereas in the study of Pekyavaş et al., banding was changed every three days (Akbaş, Atay, & Yüksel, 2011; Özünlü Pekyavaş, 2013). In another study, the kinesiological tape was changed every two to three days (Thelen, Dauber, & Stoneman, 2008). The kinesiology tape application, which was applied with the insertio-origo technique, was repeated every three days, and Y tape was used for supraspinatus and deltoid muscles, and I tape taping type was used for teres minor muscles in our study. Our results showed a decrease in pain severity in the IG as in the CG, but this decrease was not clinically significant. Şimsek et al. reported that kinesiological taping combined with exercise therapy in SIS was more effective than exercise alone (Şimşek et al., 2013). Patel et al. also compared shoulder stabilization exercises with kinesiological taping, and better results were obtained in the shoulder pain and disability values in the scapular stabilization exercises group compared to the CG (Patel, Bamrotia, Kharod, & Trambadia, 2013). Shakeri et al. also compared kinesiological tape with its placebo effect in pain and pain-free range of motion in patients with SIS (Shakeri, Keshavarz, Arab, & Ebrahimi, 2013). It was concluded that kinesiological taping reduces night pain and instant pain. According to our results, the pain scores of the IG were similar to the CG. Under normal conditions, various mechanisms have been proposed to explain the pain control mechanisms of kinesiological taping. First of all, considering that increased intramuscular pressure causes pain by stimulating the nociceptors, the lifting force created by kinesiological taping on the skin contributes to the reduction of pain by reducing the pressure on the nociceptors. Secondly, it is thought that its neurophysiological effect may prevent the passage of pain at the spinal level with the gate control mechanism. The third is that, as a result of supporting a painful joint with appropriate technique, pain reduction, and functional mobility can be increased. In this study, kinesiological taping used for pain control showed similar results to conventional methods. This may be related to the fact that most of our cases were Stage II SIS and the high number of participants with a history of trauma. On the other hand, the fact that the mean age of the IG was significantly higher than the subjects in the CG may also have contributed to the high perception of pain, which is a subjective emotion.

The pain caused by impingement syndrome in the shoulder girdle impairs daily life activities and physical functions (Gunay Ucurum, Kaya, Kayali, Askin, & Tekindal, 2018). Marzetti et al. also reported improvements in both Quick-DASH and the American Shoulder and Elbow Association Score, which assesses functionality, in patients with stage I impingement syndrome who received conventional physiotherapy (Marzetti et al., 2014). A study comparing traditional physiotherapy, functional shoulder straps, and exercise programs in patients with SIS observed that all three groups had a reduction in pain and improvements in functional status (Walther, Werner, Stahlschmidt, Woelfel, & Gohlke, 2004). Johanson et al. also stated that continuous mode ultrasound application increases the functionality of patients with SIS (Johansson, Adolfsson, & Foldevi, 2005).

According to Yılmaz et al., electrophysiological agents and exercise programs applied five days a week for three weeks are effective treatment methods for patients with SIS (Yılmaz & Tuncer, 2015).

There is a relationship between shoulder pain and functionality and disability level (Hill, Lester, Taylor, Shanahan, & Gill, 2011). Our study found similar improvements in Quick-DASH and SDQ scores after kinesiological taping. Frazier et al. observed positive results in pain, function, and disability parameters with kinesiology taping in their case series with a diagnosis of shoulder pain, subacromial impingement syndrome of the shoulder, rotator cuff tear, and acromioplasty, and they stated that kinesiology taping could be an adjunct treatment to a comprehensive physiotherapy program (Jaraczewska, Long, Frazier, Whitman, & Smith, 2006). Kaya et al. compared a home exercise program with a two-week treatment program consisting of kinesiological taping and physiotherapy modalities. It was observed that kinesiology taping significantly reduced pain after the first week, but at the end of the second week, there was a significant decrease in pain and functionality in both groups (Kaya, Zinnuroglu, & Tugcu, 2011). Shaheen et al. investigated the effects of rigid and elastic taping techniques on scapular kinematics. It has been reported that both taping methods have no impact on scapular kinematics but are effective in movements in the scapular plane (Shaheen, Bull, & Alexander, 2015). Our results showed improvements in the functional levels and disability status of both groups, but this improvement did not differ between the groups. The positive developments observed in both groups at the end of the treatment can be attributed to the effects of TENS treatment on pain, the effect of US treatment on edema and inflammation, and the positive effects of exercises on scapula biomechanics.

According to the results of this study, kinesiological taping, performed in early period of physiotherapy program, did not have a significant clinical effect in reducing pain and improving functional status and disability when applied in addition to CPP compared to CPP alone. In patients with SIS, kinesiological taping alone may not be sufficient as an alternative treatment to conventional methods. However, we think that the effects of banding and different treatment combinations should be evaluated based on the stages of SIS. Changing the taping technique and tension force in future studies may also contribute to the literature.

The study had some limitations. Our research includes the short-term effects of treatment programs. There is a need to investigate the effectiveness of combinations of taping, conventional therapy and different manual therapy applications in the long term.

Declaration of Conflicting Interests

All authors declare no conflicts of interest.

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Ethical Aspect of the Study

The Medipol University Ethics Committee approved the study with decision number 228. Written informed consent was obtained from all patients and the study was conducted under the Helsinki Declaration.

Author Contributions

Study Design: AYO, YB; Data Collection: YB; Statistical Analysis, EŞ, AYO; Data Interpretation: EŞ, AYO; Manuscript Preparation: EŞ, YB; Literature Search: AYO, YB, EŞ. All authors have read and agreed to the published version of the manuscript.

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