



## RESEARCH ARTICLE

### OVERUSE INJURIES: EFFECT OF KINESIO-TAPING ON SHOULDER PAIN IN ADOLESCENTS

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#### ARTICLE INFO

##### Article History:

Received 15<sup>th</sup> June, 2022

Received in revised form

14<sup>th</sup> July, 2022

Accepted 17<sup>th</sup> August, 2022

Published online 15<sup>th</sup> September, 2022

##### Keywords:

Kinesio-Taping, Shoulder Overuse Injury, shoulder pain, swimmers' Rehabilitation

#### ABSTRACT

**Background:** Swimmer's shoulder pain is one of the most common injuries in elite swimmers; it is estimated that up to 65% of competitive swimmers will experience a problem with their shoulders at some point in their careers. In general, suffering a shoulder injury can affect the shoulder joint's stability and mobility, and can affect the overall performance of swimmer athletes. **Aim of the study:** The study aimed at investigating the effect of Kinesio-taping on shoulder pain in the rehabilitation of adolescent swimmers with shoulder overuse injuries. **Methods:** Fifty adolescent swimmers of both genders, aged between 10 and 14 years and suffering from shoulder pain were selected and randomized into two equal groups (25 patients each). The first group received physical therapy program (i.e., strengthening exercises, stretching, and range of motion exercises) in addition to Kinesio-taping. The second group received only physical therapy program. After 12 sessions, the shoulder pain of both groups was assessed. **Results:** Kinesio-taping produced a significant reduction in shoulder pain and a significant increase in the Pain threshold of the study group compared to controls ( $p < 0.0001$ ) after applying kinesio-tape in the study group compared with controls. **Conclusion:** Kinesio-taping is an effective therapeutic modality that can be added to rehabilitation programs for the sake of treating overuse injuries in adolescent competitive swimmers.

#### INTRODUCTION

Shoulder overuse injuries (SOI) have been reported to be common among elite swimmers with a prevalence rate of 40-91%(1). Swimmer's shoulder is defined as a gradual-onset, microtrauma-induced condition that develops after repetitive stress is placed on the shoulder structures. It often manifests in form of subacromial impingement that involves the rotator cuff (RC) tendons, biceps tendon, or subacromial bursa (2). Swimming injuries can be contributed to several causes, including overtraining, insufficient recovery periods, poor swimming techniques, poor breathing techniques, poor flexibility, or range of motion (ROM), diminished RC or scapular strength, weak or unstable core, and decreased strength of the hip muscle (2,3). Swimmer's shoulder is a general term that describes several injuries related to both swimmers and non-swimmers. Because the shoulder is a biomechanically complex joint, many factors associated with the swimming stroke can lead to shoulder pain. Pain can be localized in the affected shoulder or can refer to distant body parts, such as, thoracic, cervical, and upper arm regions. Elite swimmers perform as many as 2,500 shoulder revolutions per day. Therefore, shoulder problems in this population are attributed to overuse (4). Regardless the swimmers' competitive levels, the most common shoulder-related complaint among the swimming population is shoulder pain. It can be intrinsic (i.e., due to tendon morphology, vascularity) or extrinsic (i.e., acromion shape, stroke mechanics, muscle imbalance).

Both types of shoulder pain affect how and why a swimmer experiences shoulder pain. A vivid example of an extrinsic factor leading to shoulder pain is when a swimmer crosses the midline during hand entry. This crossing results in an increased internal rotation and results in rotator-cuff-related shoulder pain (RCRSP)(2). The resulting pain is recognized as multifactorial-in-origin, and it can be affected by the following issues: abnormal stroke biomechanics, overuse, fatigue or improper control, abnormal utilization of the shoulder, scapula, and upper back muscles, and glenohumeral laxity (4). Shoulder pain primarily occurs because of the muscular imbalance between dominant muscles (adductors, internal rotators) and stabilizing muscles (rotator cuff). When these muscles are imbalanced, activation and control deficits take place leading to superior and anterior translation of the humeral head often associated with posterior capsular. This translation and poor control result in the collision of the humerus head with the soft tissue structures around it (supraspinatus, subacromial bursa, biceps tendon). This collisional friction manifests as RCSHP and discomfort that are worsened if the swimmer continues training at the same pre-injury intensity and frequency (4). According to the current statistics, more than 30% of swimmers will miss competition or training because of injury. Additionally, as many as 91% of swimmers between 13 and 25 years of age frequently experience shoulder pain (5). While up to 65% of competitive swimmers have a shoulder problem, especially when they swim 6 to 8 miles/day or more (6). Like several soft tissue injuries, the initial treatment for shoulder

injury is "RICE" which stands for: Rest, Ice, Compression, and Elevation. In the acute phase, the patient will not be able to lift his arm through the full range or sleep comfortably. Therefore, movements which provoke shoulder pain in the first place must be discontinued or avoided (7) in addition to stretching shortened muscles to restore muscle balance, strengthening exercises, muscle re-education, and mobilization of shoulder joint and scapula (2). Kinesio-taping (KT) is a taping technique designed to promote the healing process, provide support, and stabilize muscles and joints while placing no restrictions to the body's ROM. It is a safe technique for patients from all age group, either pediatric or geriatric, and it effectively treats several orthopedic, neuromuscular, neurological, and other medical conditions (8). KT can be used alone or in combination with other interventions for several purposes, the main purposes, however, are to reduce pain and improve function in patients with shoulder pain (9). The effectiveness of KT has been reported in several aspects. Namely, in proprioceptive facilitation, muscle energy restoration, reduction of delayed-onset muscle soreness, pain inhibition, promotion of healing, oedema reduction, and improving lymphatic drainage and blood flow (10).

Kinesiology tape (KT) is used for treating athletic injuries and a variety of physical disorders. For the first decade after its introduction, practitioners in Japan were the main users of the therapeutic KT. By 1988, the tape had been adopted by Japanese Olympic and professional athletes before spreading across the world. Based on the reported therapeutic effects of KT, Physical therapists use kinesiology taping as one part of an overall treatment plan in sports injuries. The American Physical Therapy Association reports that KT is most effective when it is used in conjunction with other treatments like manual therapy (11). Therapeutic uses of Kinesio-taping include a) supporting weak zones, b) Re-educating muscles, c) enhancing performance, and d) managing scars(4). In the current study, KT was used in conjunction with conventional physiotherapy technique to improve shoulder pain in adolescent competitive swimmers with shoulder overuse injuries.

## MATERIALS AND METHODS

**Subjects:** Fifty adolescent swimmers of both genders, aged between 10 and 14 years and suffering from shoulder pain were selected based on the determined inclusion criteria. Patients who demonstrated history of operations on the shoulder, upper extremity fractures, neurovascular impairments, previous shoulder joint injuries, or other orthopedic and neurological conditions were excluded from the study. Selected participants were randomly assigned into two equal groups (25 patients each):

**Group A (Study group):** This group included 25 adolescent swimmers suffering from shoulder pain who received physical therapy program in form of strengthening exercises, stretching, and ROM exercises, in addition to Kinesio-taping.

**Group B (Control group):** This group included 25 adolescent swimmers suffering from shoulder pain who received only the physical therapy program in form of strengthening exercises, stretching, and ROM exercises. Ethical consideration: The current study protocol obtained approval of the Research Ethical Committee at the Faculty of Physical Therapy, Cairo University. (Approval number: P.T.REC/ 012/002913).

**Consenting to participation:** A detailed explanation of the study significance and procedures was provided to all participants and their /surrogates, and signed consent was obtained from them prior to inclusion.

**Evaluation procedures:** After inclusion and randomization, participants were assessed using different methods to conduct pre- and post-treatment within and between-group comparisons. The assessment included TWO different values:

**Shoulder Pain and Disability Index (SPADI):** A self-administered questionnaire of two dimensions, the first dimension assesses pain while the other assesses competency during functional activities. The former contains five questions related to pain severity. The latter contains eight questions measuring the degree of difficulty an individual faces while performing ADLs that require upper-limb use. The SPADI takes 5 to 10 minutes for a patient to complete, and it is the only reliable and valid region-specific measure for the shoulder (12).

**Pressure algometry to assess pain intensity:** An algometer was used to identify the pressure and/or force eliciting a pressure-pain threshold (PPT) (13).

### Treatment Procedures:

**Physical Therapy Program:** A comprehensive rehabilitation program was performed for both groups including strengthening of the rotator cuff and scapular stabilizers, stretching anterior chest musculature that may be shortened, and modifying, if necessary, the training regime also included strengthening the muscles that support the shoulder aimed at keeping the shoulder joint stable. Keeping these muscles strong could relieve shoulder pain and prevent further injury. (14) A detailed explanation of the exercise prescription used in this study is explained in table (1).

**Kinesio-taping (KT):** Patient in study group received the beforementioned physiotherapy treatment in addition to Kinesio-taping technique for three successive months. After proper skin preparation, the anchor and the end of the tape were applied with no tension with the body of the tape stretched 40-60% of the original length. The tape could be left on for 3 – 5 days, and the skin was left to rest for at least 24 hours between applications and it was inspected for signs of irritation or a reaction before a tape was reapplied.

**Tape application:** Kinesio tape was applied in the shape of an 'I' because it was reported to be primarily used in edema and pain in addition to their use in acute injuries in place of 'Y' tape, and in alignment correction(15,16). The shape selection depended on the size of the affected muscle and the desired result. So, to decrease pain, KT was applied over the deltoid from insertion to origin to inhibit muscle fibers as and it was stretched with paper off tension (10 – 15%) with no tension applied over the ends of the tape(15).

### STATISTICAL ANALYSIS:

Unpaired t-test were conducted for comparison of the mean age, weight, and height between groups. Chi squared test was conducted for comparison of sex distribution between groups. Unpaired t test was conducted for comparison of mean values of shoulder SPADI and PPT between groups.

Paired t test was conducted for comparison of shoulder SPADI and PPT between pre and post treatment in each group. The level of significance for all statistical tests was set at  $p < 0.05$ . All statistical measures were performed through the statistical package for social sciences (SPSS) version 25 for windows.

## RESULTS

**Demographic data of participants:** For sample homogeneity, the demographic data of participants (i.e., age, sex, weight, and height) were recorded and analyzed. No significant difference was found in demographic variables between study and control groups. ( $p > 0.05$ ). (Table 2)

**Measured outcomes comparison:** Measured variables (SPADI scores and PPT) revealed a significant improvement in values ( $p < 0.05$ ). However, when study and controls were compared, a more significant improvement was noted in all parameters of the study group compared to those of the control group. (Table 3).

## DISCUSSION

Swimmer's shoulder is a condition with a gradual onset due to repetitive activity and can be classified as microtrauma. (2) Recently, the literature reports the prevalence of Swimmer's shoulder to be as high as 91% which makes it count as the most frequent musculoskeletal injury among competitive swimmers (17) Shoulder pain in competitive swimmers can be caused by several etiologies; for instance, subacromial impingement syndrome, SOI, and subsequent muscle fatigue, laxity or instability, labrum damage, scapular dyskinesia, acromial, and suprascapular neuropathies (3). Swimming is a sport that combines endurance, strength, flexibility, and control in a coordinated and repetitive manner. High levels of training easily overload soft tissue structures surrounding the shoulder leading to pain, dissatisfaction, and disability. This pathomechanical description gives rise to what is known as "swimmers shoulder". The risk factors for a swimmer's shoulder include poor endurance, incoordination, shoulder muscle weakness, lack of scapular stability, poor posture, and poor core stability (3).

Kinesio taping is a new, simple, and effective treatment for musculoskeletal disease (6). Therefore, the present study investigated the effect of KT on shoulder pain in adolescent competitive swimmers who suffered from shoulder pain due to SOI. KT was used in combination with the routine physical therapy program in the study group and the measured outcomes were compared to a control group. In the current study, physical therapy treatment alone significantly increased the pressure threshold (PPT) of the control group by 46.3%. ( $p < 0.05$ ) When KT was added to the physiotherapy program in the study group, the pain pressure threshold significantly increased by 165.7%. ( $p < 0.05$ ). Which draws a conclusion that KT is significantly more effective in reducing pain and improving pain threshold when combined with physiotherapy program than physiotherapy alone. In terms of function, in the control group, the SPADI scores of patients have significantly decreased by 18.8% after receiving physical therapy treatment ( $p = 0.0001$ ). In the study group, the SPADI scores of patients have significantly decreased by 58.9% after receiving physical therapy treatment in addition to kinesio-taping ( $p = 0.0001$ ). Although both groups showed a significant improvement in their SPADI scores, when both groups were compared, it was

found that combining KT with physical therapy treatment yields a significantly greater improvement by around 40% in the SPADI scores compared with physical therapy alone. ( $p = 0.0001$ ). In general, the results of the current study show that patients who received exercises in combination with Kinesio-taping showed a greater reduction of pain which can be attributed to the combined effect of the two methods. These results were consistent with the findings of Kaya et al., 2011(12) who revealed a greater pain reduction after applying KT compared with application of physical therapy alone. These results were also in agreement with Sikha et al., (2017) who investigated the effect of KT on pain, function, and quality of life in patients with subacromial impingement compared with conventional physical therapy treatment. After 4 weeks in the rehabilitation program, more significant improvements were observed in the KT group including improvements in shoulder function based on the PENN shoulder score (18).

Yang et al., 2018 revealed similar results when they applied KT on the shoulders of hemiplegic patients. They found a significant immediate improvement in shoulder's active range of motion (AROM) and a significant decrease in pain intensity. After four weeks of rehabilitation, they reported an overall decrease in pain intensity and an improvement in AROM, sub-laxity and muscle activity. They reached a conclusion that KT is effective in treating shoulder pain especially when immediate results are required (18). Another study by Tiga-Loza et al., (2020) compared the effects of KT on shoulder pain, strength, and ROM with and without physical therapy treatment. Regarding pain, KT alone could reduce pain, more significant improvements were observed when combining it with other physical therapy modalities (20). The results of the current study were also in agreement with Muhammad et al., (2020) who conducted a study to investigate the effect of kinesiology tape combined with conventional physical therapy in patients with shoulder impingement syndrome (SIS). This study revealed a more significant improvement in pain intensity based on patients' SPADI and VAS scores when KT was combined with conventional physical therapy. Muhammad et al., (2020) and Tantawy and Kamel (2016) also reported a significant effect of KT in improving pain intensity, disability scores, and shoulder ROM. Therefore, KT can be used in combination with physical therapy interventions (22).

In another recent study that was conducted on 30 patients with adhesive capsulitis, it was reported that the greater improvement in pain and ROM was witnessed immediately after applying kinesio-tape. While less significant improvement was reported after three weeks of treatment. Suggesting that KT is effective in eliminating pain and improving ROM and function when immediate effect is required (23). Similarly, a systematic review conducted by Artioli and Bertolini, (2014) included 10 different studies that investigated the effect of KT on pain reduction by comparing it to other pain-control modalities. After analyzing the results of these studies, they drew a conclusion that The KT produces hypoalgesic effects like those of other experimental groups. Only three out of the ten studies suggested that KT's effects on pain were higher, in the short term (24 hours after application), and its results are, mostly, described as beneficial, however due to the short duration of the studies, there is no scientific evidence that these effects may be prolonged, which, clinically, does not justify KT use as a primary analgesic technique (24).

Table 1. A detailed explanation of the exercise prescription used in this study (14)

Exercise	Muscles Targeted	Equipment used	Prescription
<b>Stretching and mobility exercises</b>			
Pendulum exercises	Deltoids, supraspinatus, infraspinatus, subscapularis.	None	2 sets of 10 reps
Crossover Arm Stretch:	Posterior deltoid	None	4 repetitions for each side
Passive Internal Rotation	Subscapularis.	Light Stick or yardstick	4 repetitions for each side
Passive External Rotation	teres minor	Light Stick or yardstick	4 repetitions for each side
<b>Strengthening Exercises</b>			
Standing Row	Middle and lower trapezius	elastic stretch band of comfortable resistance	Slowly progressing to 3 sets of 12 repetitions
External Rotation with Arm Abducted 90°	Infraspinatus and teres minor		
Internal Rotation	Subscapularis		
External Rotation	Infraspinatus, teres minor, posterior deltoid		
Main muscles worked	Middle and posterior deltoid, middle trapezius	Light weight	2 sets of 8 to 10 reps and progress to 3 x 15. gradually add weight in 1lb increments to a maximum of 5 lb.
Scapular Retraction/Protraction	Middle trapezius, serratus anterior		3 sets of 8 reps and progress to 3x12. Add weight in 1-lb increments to a maximum of 5 lb.
Bent-Over Horizontal Abduction	Middle and lower trapezius, Infraspinatus, teres minor, posterior deltoid.		3 to 4 sets x 20 reps without pain. slowly add 2 to 3 lb but do fewer repetitions. Progress to 3 x 15 at each weight increment, maximum weight 5 to 7 lb.
Internal and External Rotation	Internal rotation: anterior deltoid, pectoralis, subscapularis, latissimus. External rotation: posterior deltoid, infraspinatus, teres minor.		10 repetitions
Scapula Setting	Middle trapezius, serratus.	None	

Table 1. Demographic data of participants

	Control group	Study group	MD	t- value	p-value	Sig
	$\bar{X} \pm SD$	$\bar{X} \pm SD$				
Age (years)	12.56 ± 1.47	12.6 ± 1.41	-0.04	-0.09	0.92	NS
Weight (kg)	44.55 ± 7.74	44.42 ± 8.04	0.13	0.05	0.95	NS
Height (cm)	155.6 ± 11.11	154.56 ± 9.15	1.04	0.36	0.72	NS
<b>Sex Distribution</b>						
	Control group	Study group	$\chi^2$	p-value	Sig	
Girls	12 (48%)	14 (56%)				
Boys	13 (52%)	11 (44%)				

$\bar{X}$  : Mean    SD: Standard deviation    MD: Mean difference  
t value: Unpaired t value    p value: Probability value    NS: Non-significant  
 $\chi^2$ : Chi squared value    p value: Probability value

Table 3. Comparison of post-treatment mean values of shoulder ROM, SPADI scores and PPT between control and study groups

	Control group	Study group	MD	t- value	p-value	Sig
	$\bar{X} \pm SD$	$\bar{X} \pm SD$				
SPADI Score(%)	58.4 ± 15.72	31.38 ± 19.18	27.02	5.44	0.0001	S
PPT (N)	4.04 ± 0.93	7.44 ± 1.08	-3.4	-11.88	0.0001	S

$\bar{x}$ : Mean    SD: Standard deviation    MD: Mean difference  
t value: Unpaired t value    p-value: Probability value    S: Significant

It is also worth mentioning that Akbaş et al., (2011) did not find significant pain reduction despite the addition of physical therapy treatment and concluded that KT was not even superior to sham taping/placebo taping (25). In 2020, contradictory results were also reported by Perry and Lipincott who assessed the effect of Kinesio-taping versus no taping on shoulder stability and function. In this study, kinesio taping had no effect on stability and function of the shoulder joint (26). To conclude, although some degree of controversy is still present, literature has shed light on the effectiveness of KT in several orthopedic and neurological conditions when the goal is to decrease pain, improve ROM and function of the injured body part.

The current study has also added supporting evidence that KT can make a good choice of non-invasive rehabilitation aid, especially for children and adolescents, as it adds to the benefit of exercise in the treatment of shoulder injuries in adolescent swimmers. Recent studies assumed that the possible mechanisms by which KT relieves pain are as follows. First, following KT application, the skin is lifted by folds, when there is an increase in the space between superficial skin and its underlying connective tissues, blood and lymph circulations accelerate, and inflammatory factors are dissipated. Thus, leading to pain reduction (15). Afterwards, mechanical stimulation of the skin through KT increases the afferent stimulation of large-diameter nerve fibers and reduces the

afferent input received by small-diameter nerve fibers, such as nociceptors, thereby reducing pain sensation (i.e., gate theory) (27,28). Afterward, KT increases blood circulation and muscle temperature by stimulating the vasomotor reflex, and the associated increase in metabolic activity may reduce pain. (15,29). Finally, owing to the sense of stability and security generated by KT, the psychologically expected response of the subjects may increase, thereby inducing placebo effects(30). However, this series of processes is only a hypothesis deduced from experimentally observed phenomena. As a bottom line, a comprehensive rehabilitation program must include strengthening of the rotator cuff and scapular stabilizers, stretching anterior chest musculature that may be shortened, and implementing activity modification so the athlete can still participate in the sport(2) in addition to novel modalities such as KT. Yet, the contradicting results must be taken into consideration; if Kinesio-taping is to be included in future rehabilitation plans, more research must be conducted to understand the factors that may interfere with its reported effectiveness. KT effectiveness can be further proved by including bigger sample sizes and prolonging the study period.

## CONCLUSION

Kinesio-taping is a safe, easy-to-apply modality that can add to the benefit of a comprehensive rehabilitation program in pain reduction for adolescent swimmers with overuse shoulder injury.

**Source of Funding:** This study had not received any financial support.

**Conflict of Interests:** Authors declared that there is no conflict of interests.

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