Does Kinesio taping in addition to exercise therapy improve the outcomes in subacromial impingement syndrome? A randomized, double-blind, controlled clinical trial

Article *in* acta orthopaedica et traumatologica turcica · April 2013

DOI: 10.3944/AOTT.2013.2782 · Source: PubMed

CITATIONS
65

READS
1,281

5 authors, including:

Hacer Hicran Simşek
Sivas Cumhuriyet University
1 PUBLICATION **65** CITATIONS
SEE PROFILE

Selvin Balki
Sivas Cumhuriyet University
3 PUBLICATIONS **77** CITATIONS
SEE PROFILE

Sinem suner keklik
Gazi University
1 PUBLICATION **65** CITATIONS
SEE PROFILE

ORIGINAL ARTICLE

Acta Orthop Traumatol Turc 2013;47(2):104-110
doi:10.3944/AOTT.2013.2782

Does Kinesio taping in addition to exercise therapy improve the outcomes in subacromial impingement syndrome? A randomized, double-blind, controlled clinical trial

Hacer Hicran ŞİMŞEK[1], Selvin BALKİ[2], Sinem Suner KEKLİK[1], Hayati ÖZTÜRK[3], Hasan ELDEN[4]

[1]Institute of Health Sciences, Cumhuriyet University, Sivas, Turkey;
[2]Department of Physiotherapy and Rehabilitation, Faculty of Health Sciences, Cumhuriyet University, Sivas, Turkey;
[3]Department of Orthopedics and Traumatology, Faculty of Medicine, Cumhuriyet University, Sivas, Turkey;
[4]Department of Physical Medicine and Rehabilitation, Faculty of Medicine, Cumhuriyet University, Sivas, Turkey

Objective: The aim of this study was to determine the effectiveness of Kinesio taping (KT) application added to the exercise treatment of subacromial impingement syndrome (SIS).

Methods: Thirty-eight (25 female, 13 male) patients with SIS were randomly divided into therapeutic KT (n=19) and sham KT (n=19) groups. All patients received the same exercise therapy in addition to therapeutic or sham KT at 3-day intervals for 12 days. The groups were compared according to pain, range of motion (ROM), muscle strength and DASH and Constant scores before treatment and at the 5th and 12th treatment days.

Results: Within group comparisons showed significant improvements in both groups at the 5th and 12th day evaluations ($p<0.05$). In comparisons between the groups, pain with movement and DASH scores in the therapeutic group were significantly lower at the 5th day ($p<0.01$). There were significant improvements in night pain, pain with movement, DASH score, shoulder external rotation muscle strength, and pain free shoulder abduction ROM in the therapeutic group at the 12th day ($p<0.05$). Passive shoulder flexion ROM increased more in the sham group at the 12th day ($p<0.05$).

Conclusion: The addition of KT application to the exercise program appears to be more effective than the exercise program alone for the treatment of SIS.

Key words: Exercise therapy; function; Kinesio tape; pain; subacromial impingement syndrome.

Shoulder pain is the second most common pathology following lower back pain.[1] Subacromial impingement syndrome (SIS) is one of the leading causes of shoulder pain and impairment.[2,3] SIS occurs following the entrapment of the supraspinatus, infraspinatus, teres minor muscle and biceps tendon, soft tissues and subacromial bursa between the coracoacromial arch and humeral head[4] and causes swelling, inflammation and pain in the shoulder. Structural and functional factors narrowing the subacromial space may lead to SIS.

Correspondence: Selvin Balki, PT, PhD. Cumhuriyet Üniversitesi, Sağlık Bilimleri Fakültesi Fizyoterapi ve Rehabilitasyon Bölümü, 58140, Sivas, Turkey.
Tel: +90 346 - 210 10 10 e-mail: sbalki@cumhuriyet.edu.tr

Submitted: November 25, 2011 **Accepted:** December 11, 2012

Available online at
www.aott.org.tr
doi:10.3944/AOTT.2013.2782
QR (Quick Response) Code:

Most cases with SIS are in patients under 60 years of age who are exposed to recurrent trauma through consistent use of their arms above the shoulder level.[4]

Various treatments for the management of SIS including physical therapy methods, surgical approaches, subacromial corticosteroid injection and NSAIDs have been attempted in addition to strengthening and stretching exercises.[1,5-16] However, there is still a lack of scientific evidence on the effectiveness of these treatment methods.[11] Physiotherapy for shoulder pain may consist of exercises,[6,8] manipulative treatments,[9,10] several electrotherapy techniques,[13,14] and taping.[15,16]

Taping is used in combination with other physiotherapy methods to reduce pain and improve functional recovery during shoulder rehabilitation.[15-17] Several types of elastic or rigid tapes and techniques have been developed for this purpose.

Kinesio tape (KT) is an elastic tape used to modulate physiological processes such as pain, inflammation, muscle activity, and circulation and to support rehabilitation applications.[16-22] The Kinesio® Tex tape used in this method allows for sporting activities and exercises as it can stretch up to 120 to 140% of its original length.[18] This feature allows for its current use in exercise therapy and sporting activities. However, its effectiveness or probable influence on the outcomes of combined exercise therapy is still not clear. In a recent study, Akbaş et al. showed that KT and exercise therapy together yielded better results by increasing the flexibility of the soft tissue in a shorter period when compared with exercise therapy alone in treatment of patellofemoral pain.[19]

Miller and Osmotherly[16] studied SIS patients with shoulder pain lasting for a duration of more than 6 weeks. One group was given exercise and manipulative therapy and compared to a second group on which rigid and elastic tape was applied over the scapula in addition to the exercise therapy. The scapular tape application group had better results in terms of shoulder pain and motion on the second week.

In a case series, patients with shoulder pain and disability were given strengthening exercises for rotator cuff and scapular stabilizer muscles, mobilization and hot/cold treatment combined with KT application. The pain was reduced and functions improved in the fourth and eighth week assessments.[20]

Kaya et al.[17] compared the results of home exercise therapy and KT to physiotherapy in patients with shoulder pain due to SIS for an average of 6 months. They recorded that the KT group showed significant improvements in terms of pain and function in the first and second weeks. In another study without exercise and other treatment modalities, therapeutic KT did not significantly contribute to reducing pain and improving functions in the short-term when compared with sham KT application in SIS.[21]

Although treatment programs including exercise and KT applications provide pain reduction and functional improvement, the effectiveness of therapeutic KT associated with exercise therapy in SIS has not been separately investigated. This study was designed with the hypothesis that therapeutic KT in addition to exercise therapies in SIS could return positive results. For this purpose, sham and therapeutic KT application in SIS exercise therapies and their contributions to reducing pain and disability and to increases in muscle strength and flexibility were evaluated.

Patients and methods

Patients with complaints of shoulder pain were first evaluated by an orthopedic surgeon and diagnosis of SIS was made following review of plain radiography and MR images. The study included 38 patients (25 females, 13 males; mean age: 51 years, range: 18 to 69 years) with SIS. The Ethical Commission of Cumhuriyet University approved the study and the patients gave written informed consent.

Patients between the ages of 18 and 70, with pain interfering with the patient's daily routine, lasting for one month or longer and with positive Neer and Hawkin's impingement test results were included in the study.

Patients with symptoms such as calcific tendinitis and degenerative arthritis in plain roentgenograms, pathological findings in addition to subacromial effusion in MR images, a history of shoulder, waist and chest surgery, fracture or dislocation of the affected shoulder, cervical problems accompanied by radicular symptoms, inflammatory joint disease, and physiotherapy for the shoulder within last three months were excluded from the study.

The patients were randomized into two groups of 19 cases; the therapeutic KT group (11 females, 8 males; mean age: 48 years) and the sham KT group (14 females, 5 males; mean age: 53 years). The dominant shoulder was affected in 52% of the patients in the treatment and 63% in the sham group. Assessments were performed before the treatment and on the 5th and 12th days by a researcher blinded to the information about the patient and the group. Fifth and 12th day assessments were done with the tape well-concealed under the patient's clothing. Kinesio taping was applied immediately following initial measurements by a certified physiotherapist. None of the patients had received previous KT treatment.

The severity of pain at rest, sleep and during an activity was determined based on the 10-cm visual analog scale (VAS). The Turkish version of the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire[23] and Constant score[24] were used in functional assessments. Active and passive range of motion (ROM) of the shoulder and painless ROM of the shoulder joint was measured using a conventional goniometer. Isometric muscle strength measurements of the shoulder joint were performed using a Baseline® hand dynamometer (Fabrication Enterprises Inc., NY, USA). Measurements were performed on the flexion, extension, abduction, external, and internal rotation muscle groups of the affected shoulder based on the guidelines defined by Andrews et al.[25] A trial was performed prior to each measurement and two measurements were then performed at an interval of 1 to 2 minutes. Mean muscle strength results defined in kilogram-force was then taken into account.

Therapeutic and sham KT applications were performed as described by Thelen et al.[21] for acute shoulder pain (Fig. 1). Taping over the deltoid and supraspinatus muscles was done using the insertion-origin muscle technique. The 50 to 75% stretched I-band was applied using the mechanical correction technique. No additional stretch was applied in tapings over the muscles and sham group. Sham taping does not have a therapeutic effect.

A 5-cm Kinesio® Tex Gold tape was used in both groups. The treatment was repeated for 12 days with 3-day applications (Fig. 1).

Patients were given exercises defined by Hughston and Riivald. These exercises are recommended within functional rehabilitation of SIS and aim to achieve scapular stabilization and distal mobility.[26] Hughston's six exercises were performed to strengthen the rotator cuff muscles of the shoulder with the patient in a prone position. Following Hughston's exercises, dynamic scapular stabilization moves developed by Riivald were performed, using a red Thera-Band®. Thera-Band® can exert an elastic resistance of 0.7 kg when stretched to 125% of its original size.[27] All exercises were begun with 5 reps and increased to 15 reps as tolerated. Training was performed once a day, for 5 days a week under supervision of a physiotherapist and lasted two weeks. Patients were asked to repeat the exercises as one set during weekdays and two sets on weekends at home.

A minimum of 17 patients per group was necessary for 80% statistical power. SPSS v14.0 was used in the statistical analysis of the obtained findings. The Mann-Whitney U test was used in intergroup analyses and the Wilcoxon signed-rank test for intergroup analyses. The chi-square test was used for analyzing count data. Level of significance was accepted as $p<0.05$.

Results

No statistically significant difference was found in terms of sex, age and affected shoulder between the groups ($p>0.05$). There was no significant difference in duration of pain between the therapeutic KT (10.37±8.26 months) and sham KT (10.37±6.65 months) groups ($p>0.05$). Groups were not standardized prior to treatment for measurement of the shoulder muscle strength in flexion, active ROM in flexion, and painless ROM during internal rotation.

Table 1 presents pain, function and painless ROM, Table 2 active and passive ROM and Table 3 muscle

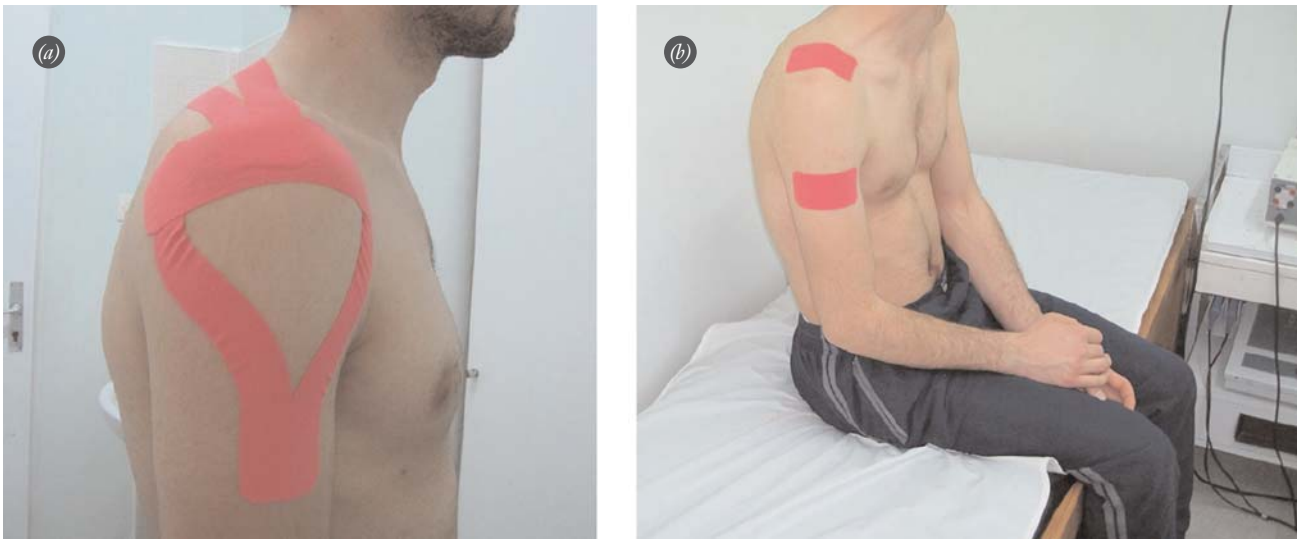

Fig. 1. **(a)** Therapeutic KT and **(b)** sham KT. [Color figure can be viewed in the online issue, which is available at www.aott.org.tr]

Table 1. Intragroup and intergroup comparisons of pain, function and painless range of motion.

Time	Therapeutic KT (n=19) mean±SD	Sham KT (n=19) mean±SD	Intergroup statistics (p)
Rest visual analog scale-VAS (cm)			
Pretreatment	2.74±2.73	3.21±2.92	0.644
5th day	1.74±2.06*	2.61±2.72†	0.563
12th day	1.43±2.22*	2.65±2.67‡	0.116
Activity visual analog scale-VAS (cm)			
Pretreatment	7.12±2.21	7.96±1.25	0.370
5th day	4.87±2.29*	6.71±1.68*	**0.010**
12th day	4.32±2.64*	6.28±1.93*	**0.009**
Night visual analog scale-VAS (cm)			
Pretreatment	6.23±3.42	6.74±3.03	0.624
5th day	3.36±2.83*	5.38±3.35*	0.065
12th day	2.37±3.19*	4.82±2.95*	**0.018**
Constant score			
Pretreatment	47.79±16.07	54.16±13.46	0.246
5th day	62.84±12.53*	59.67±12.67*	0.339
12th day	68.21±11.94*	62.53±12.74*	0.146
Disabilities of the Arm, Shoulder and Hand Questionnaire-(DASH)			
Pretreatment	46.15±19.83	52.69±16.42	0.246
5th day	30.14±17.77*	48.05±18.59†	**0.004**
12th day	25.14±17.35*	47.10±17.87†	**0.001**
Painless range of motion when the shoulder is flexed-ROM (°)			
Pretreatment	97.11±25.34	112.53± 37,73	0.234
5th day	128.68±29.57*	126.32± 35.83†	0.583
12th day	137.32±31.21*	131.05± 37.80†	0.583
Painless range of motion when the shoulder is abducted-ROM (°)			
Pretreatment	91.05±27.61	93.42±11.06	0.297
5th day	108.68±26.81†	98.42±13.92‡	0.258
12th day	128.53±30.94*	103.42±21.67†	**0.004**
Painless range of motion when the shoulder is rotated externally-ROM (°)			
Pretreatment	63.42±26.82	73.53±18.50	0.402
5th day	76.84±21.55*	76.32±17.22‡	0.840
12th day	77.11±20.43†	79.37±14.47†	0.977
Painless range of motion when the shoulder is rotated internally-ROM (°)			
Pretreatment	56.32±20.26	70.58±7.55	**0.022**
5th day	67.11±15.02*	71.74±7.99	0.385
12th day	71.32±11.76*	72.00±6.90	0.354

Wilcoxon test results compared to pretreatment results: *p<0.001, †p<0.01, ‡p<0.05. P values of 0.05 are written in bold.

strength results. Wilcoxon test results showed significant improvements in the therapeutic and sham KT groups in terms of pain, painless and active ROM, and function and muscle strength (p<0.05). Significant increases were observed in the therapeutic KT group regarding passive flexion and abduction ROM (p<0.05).

The therapeutic KT group showed more significant improvement when compared to the sham group in terms of activity pain and function (DASH) on the 5th day (p<0.01). Passive flexion ROM increased in favor of the sham group within the same period (p<0.05). The therapeutic KT group had significant improvements on the 12th day of treatment regarding night and activity pain scores, function (DASH), painless abduction ROM and muscle strength during external rotation when compared with the sham group (p<0.05).

Discussion

It is well known that therapeutic exercise programs reduce pain and functional impairment in SIS.[28] Our results showed that KT treatment in addition to exercise therapy may contribute to improvements in pain, function, painless ROM and muscle strength in patients with SIS.

Kaya et al.[17] applied KT over the supraspinatus, teres minor and deltoid muscles using the insertion-origin technique, in addition to a home exercise program in SIS patients with shoulder pain for a minimum of 2 months. They observed a significant decrease in pain and disability in the KT group in the first and second weeks. These results are consistent with our findings.

In their randomized, controlled study, Thelen et al.[21] evaluated the effect of KT application with the insertion-origin technique independent from upper extremity exercises in SIS patients with acute shoulder pain. Disability was evaluated using the shoulder pain and disability index (SPADI). No significant difference was detected between the KT and sham groups in pain and disability results following tape removal on the sixth day. We observed significant improvements in the KT group after the fifth day. This may be due to not removing the KT during assessments and/or the exercise therapy given.

Exercise programs for SIS aim to stimulate recovery in the affected tissues and improve shoulder movements without an increase in pain.[29] Celik at al. detected a significant improvement in pain level following their exercise treatment which they applied beneath the painful arch for 2 weeks in patients with SIS.[8] No cold application or anti-inflammatory drug support was required due to increasing pain during the Hughston's and Riivald's exercise therapies implemented in our study. When performed with therapeutic KT or sham KT application, these exercises were observed to lead to improvements in pain control, ROM, muscle strength, and functional status in the short-term.

Pain that occurs with movement and affects functionality are primarily dealt with during treatment for SIS. Of 11 randomized controlled studies investigating the effects of exercise in SIS, 6 discussed the effects of exer-

Table 2. Intragroup and intergroup comparisons of active and passive ranges of motion.

Time	Therapeutic KT (n=19) mean±SD	Sham KT (n=19) mean±SD	Intergroup statistics (p)
Active range of motion when the shoulder is flexed-ROM (°)			
Pretreatment	143.42±29.63	166.68± 20.23	**0.002**
5th day	157.63±22.01*	171.58± 15.88†	**0.002**
12th day	165.68±19.45*	172.89± 12.72†	**0.040**
Active range of motion when the shoulder is abducted-ROM (°)			
Pretreatment	129.50±34.07	147.26±30.74	0.061
5th day	145.68±28.62†	155.26±24.14‡	0.234
12th day	158.95±22.14*	160.58±21.44†	0.863
Active range of motion when the shoulder is rotated externally-ROM (°)			
Pretreatment	76.58±20.55	85.79±9.75	0.138
5th day	85.53±13.83†	88.42±4.73	0.624
12th day	87.89±9.18†	88.68±4.03	0.817
Active range of motion when the shoulder is rotated internally-ROM (°)			
Pretreatment	70.37±14.11	75.00±0.00	0.418
5th day	72.11±11.46	75.00±0.00	0.583
12th day	73.16±8.03	75.00±0.00	0.795
Passive range of motion when the shoulder is flexed-ROM (°)			
Pretreatment	171.84±13.96	175.53±9.98	0.123
5th day	173.47±11.44‡	178.16±4.77	**0.030**
12th day	176.11±4.87†	178.68±2.81	0.096
Passive range of motion when the shoulder is abducted-ROM (°)			
Pretreatment	163.95±23.03	170.26±19.68	0.354
5th day	166.84±18.79	175.42±6.54	0.201
12th day	173.89±11.49†	176.05±6.36	0.506
Passive range of motion when the shoulder is rotated externally-ROM (°)			
Pretreatment	88.16±5.06	88.42±6.88	0.684
5th day	89.21±3.44	90.00±0.00	0.795
12th day	89.21±3.44	90.00±0.00	0.795
Passive range of motion when the shoulder is rotated internally-ROM (°)			
Pretreatment	74.74±1.14	75.00±0.00	0.795
5th day	75.00±0.00	75.00±0.00	1.00
12th day	75.00±0.00	75.00±0.00	1.00

Wilcoxon test results compared to pretreatment results: *p<0.001, †p<0.01, ‡p<0.05. P values of 0.05 are written in bold.

Table 3. Intragroup and intergroup comparisons of muscle strength (kilogram-force).

Time	Therapeutic KT (n=19) mean±SD	Sham KT (n=19) mean±SD	Intergroup statistics (p)
Muscle strength when the shoulder is flexed			
Pretreatment	8.74±2.62	7.53±3.16	**0.032**
5th day	10.21±3.11†	8.42±3.09†	**0.050**
12th day	11.21±3.37†	8.42±3.15	**0.005**
Muscle strength when the shoulder is extended			
Pretreatment	7.74±2.62	7.58±3.32	0.544
5th day	9.21±3.88†	8.11±3.34	0.418
12th day	10.05±4.23*	8.21±3.10	0.123
Muscle strength when the shoulder is abducted			
Pretreatment	5.32±2.81	4.68±2.26	0.563
5th day	6.21±2.89‡	5.26±2.18‡	0.191
12th day	6.89±2.42†	5.47±2.14†	0.053
Muscle strength when the shoulder is rotated externally			
Pretreatment	5.68±2.81	5.47±3.04	0.665
5th day	7.42±3.08*	5.95±2.39	0.130
12th day	8.16±3.35*	5.95±2.30	**0.030**
Muscle strength when the shoulder is rotated internally			
Pretreatment	6.21±2.80	5.37±2.94	0.246
5th day	7.79±3.19*	6.37±3.25†	0.096
12th day	8.79±3.82*	6.42±3.10†	0.053

Wilcoxon test results compared to pretreatment results: *p<0.001, †p<0.01, ‡p<0.05. P values of 0.05 are written in bold.

cise on pain and 5 found exercise therapy alone to be efficient in pain control in both the short- and long-term.[28]

Kinesio taping helps reduce pain by pulling the skin upwards, thus increasing blood and lymph flow. Neurophysiological effects created by KT are believed to prevent transmission of pain in the spinal level by means of a gate-control mechanism.[18] However, the clinical significance of KT application in the treatment of pain is controversial.[30] In several controlled and uncontrolled studies, KT applications were reported to decrease pain in the shoulder,[17,20] waist[31] and neck.[32] In our study, therapeutic KT application in addition to exercise therapy caused a significant reduction in activity and night pain.

Pain is known to suppress the activity of motor neurons.[33] Bandholm et al.[34] studied the effects of acute pain on shoulder muscle strength in healthy subjects. They noted that the pain induced on the supraspinatus muscle caused a decrease in the isometric abduction strength of the shoulder by 21%. In our study, therapeutic KT application administered along with exercise caused further reduction in motion-induced pain, which was accompanied by increases in isometric muscle strength. In the literature, the efficacy of exercise in SIS has been generally followed and assessed through a period of 3 weeks or more. Our follow-up period of two weeks might be responsible for improvements being in favor of the therapeutic KT exercise group despite the application of sham KT exercise.

Kinesio tape can change joint stability and movement biomechanics with the mechanical support it creates.[18] It is believed that the skin receptors are stimulated and proprioception increases, particularly when KT is applied with the correction technique and extra stretching.[18] Lin et al. observed a change in scapular muscle activity and an increase in proprioception following KT application in subjects with no shoulder

problems.[35] Motor neurons are believed to be activated by the stimulated cutaneous mechanoreceptors.[36] Kinesio tape also causes some significant changes in muscle activity[22,35-37] although it is not clear whether these changes are beneficial or harmful.[30] Studies investigating the effects of KT on muscle strength are limited and present inconsistent results.[30,35-39] In the current study, therapeutic KT within SIS exercise therapy contributed to the increase in the muscle strength of the shoulder in external rotation.

The literature reports inconsistent outcomes of the effects of KT on ROM.[30] In some studies, KT was reported to cause an increase in ROM.[21,31,32] In our study, in addition to SIS exercise therapy, therapeutic KT application resulted in a highly significant increase in painless shoulder abduction ROM on the 12th day. Passive flexion range in the sham group was greater than the therapeutic KT group on the 5th day of treatment. Studies on the treatment of painful movement restrictions of the shoulder have shown that manipulative therapy is more efficient when compared with other treatment modalities.[9,10,40]

The short follow-up time was the main limitation of our study.

In conclusion, based on the current findings, it can be postulated that KT is effective in the rehabilitation of SIS when administered with exercise.

Acknowledgement

This work is supported by the Scientific Research Project Fund of Cumhuriyet University under project number SBF-014.

Conflicts of Interest: No conflicts declared.

References

1. Green S, Buchbinder R, Hetrick S. Physiotherapy interventions for shoulder pain. Cochrane Database Syst Rev 2003;2: CD004258.
2. Van der Windt DA, Koes BW, Boeke AJ, Devillé W, De Jong BA, Bouter LM. Shoulder disorders in general practice: prognostic indicators of outcome. Br J Gen Pract 1996;46: 519-23.
3. Michener LA, Walsworth MK, Burnet EN. Effectiveness of rehabilitation for patients with subacromial impingement syndrome: a systematic review. J Hand Ther 2004;17:152-64.
4. Neer CS. 2nd. Impingement lesions. Clin Orthop Relat Res 1983;(173):70-7.
5. Kamkar A, Irrgang JJ, Whitney SL. Nonoperative management of secondary shoulder impingement syndrome. J Orthop Sports Phys Ther 1993;17:212-24.
6. Baltacı G. Subacromial impingement syndrome in athletes: prevention and exercise programs. [Article in Turkish] Acta Orthop Traumatol Turc 2003;37 Supp l:128-38.
7. Morrison DS, Greenbaum BS, Einhorn A. Shoulder impingement. Orthop Clin North Am 2000;31:285-93.
8. Celik D, Akyüz G, Yeldan I. Comparison of the effects of two different exercise programs on pain in subacromial impingement syndrome. Acta Orthop Traumatol Turc 2009;43:504-9.
9. Rhon DI, Boyles RE, Cleland JA, Brown DL. Manual physical therapy approach versus subacromial corticosteroid injection for treatment of shoulder impingement syndrome: a protocol for a randomised clinical trial. BMJ Open 2011; 1:e000137.
10. Senbursa G, Baltaci G, Atay A. Comparison of conservative treatment with and without manual physical therapy for patients with shoulder impingement syndrome: a prospective, randomized clinical trial. Knee Surg Sports Traumatol Arthrosc 2007;15:915-21.
11. Green S, Buchbinder R, Glazier R, Forbes A. Systematic review of randomised controlled trials of interventions for painful shoulder: selection criteria, outcome assessment, and efficacy. BMJ 1998;316:354-60.
12. Celik D, Atalar AC, Güçlü A, Demirhan M. The contribution of subacromial injection to the conservative treatment of impingement syndrome. Acta Orthop Traumatol Turc 2009;43:331-5.
13. Celik D, Atalar AC, Sahinkaya S, Demirhan M. The value of intermittent ultrasound treatment in subacromial impingement syndrome. Acta Orthop Traumatol Turc 2009;43:243-7.
14. Hsu CJ, Wang DY, Tseng KF, Fong YC, Hsu HC, Jim YF. Extracorporeal shock wave therapy for calcifying tendinitis of the shoulder. J Shoulder Elbow Surg 2008;17:55-9.
15. Kalter J, Apeldoorn AT, Ostelo RW, Henschke N, Knol DL, van Tulder MW. Taping patients with clinical signs of subacromial impingement syndrome: the design of a randomized controlled trial. BMC Musculoskelet Disord 2011; 12:188.
16. Miller P, Osmotherly P. Does scapula taping facilitate recovery for shoulder impingement symptoms? A pilot randomized controlled trial. J Man Manip Ther 2009;17:E6-E13.
17. Kaya E, Zinnuroglu M, Tugcu I. Kinesio taping compared to physical therapy modalities for the treatment of shoulder impingement syndrome. Clin Rheumatol 2011;30:201-7.
18. Kase K, Wallis J, Kase T. Clinical therapeutic applications of the kinesio taping method. Tokyo: Ken Ikai Co Ltd.; 2003.
19. Akbaş E, Atay AO, Yüksel I. The effects of additional kinesio taping over exercise in the treatment of patellofemoral pain syndrome. Acta Orthop Traumatol Turc 2011;45:335-41.
20. Frazier S, Whitman J, Smith M. Utilization of kinesio tex tape in patients with shoulder pain or dysfunction: a case series. Advanced Healing 2006;Summer:18-20.
21. Thelen MD, Dauber JA, Stoneman PD. The clinical efficacy of kinesio tape for shoulder pain: a randomized, double-blinded, clinical trial. J Orthop Sports Phys Ther 2008;38: 389-95.
22. Hsu YH, Chen WY, Lin HC, Wang WT, Shih YF. The effects of taping on scapular kinematics and muscle performance in baseball players with shoulder impingement syndrome. J Electromyogr Kinesiol 2009;19:1092-9.
23. Düger T, Yakut E, Öksüz Ç, Yörükan S, Bilgütay BS, Ayhan Ç, et al. Reliability and validity of the Turkish version of the Disabilities of the Arm, Shoulder and Hand (DASH) Questionnaire. [Article in Turkish] Fizyoterapi ve Rehabilitasyon 2006; 17:99-107.

24. Constant CR, Murley AH. A clinical method of functional assessment of the shoulder. Clin Orthop Relat Res 1987; (214):160-4.
25. Andrews AW, Thomas MW, Bohannon RW. Normative values for isometric muscle force measurements obtained with hand-held dynamometers. Phys Ther 1996;76:248-59.
26. Cakmak A. Conservative treatment of subacromial impingement syndrome. [Article in Turkish] Acta Orthop Traumatol Turc 2003;37 Suppl 1:112-8.
27. Page P, Ellenbecker TS. The scientific and clinical application of elastic resistance. Champaign, IL: Human Kinetics; 2003.
28. Kuhn JE. Exercise in the treatment of rotator cuff impingement: a systematic review and a synthesized evidence-based rehabilitation protocol. J Shoulder Elbow Surg 2009;18:138-60.
29. Bøhmer AS, Staff PH, Brox JI. Supervised exercises in relation to rotator cuff disease (impingement syndrome stages II and III): a treatment regimen and its rationale. Physiother Theory Pract 1998;14:93-105.
30. Williams S, Whatman C, Hume PA, Sheerin K. Kinesio taping in treatment and prevention of sports injuries: a meta-analysis of the evidence for its effectiveness. Sports Med 2012; 42:153-64.
31. Yoshida A, Kahanov L. The effect of kinesio taping on lower trunk range of motions. Res Sports Med 2007;15:103-12.
32. González-Iglesias J, Fernández-de-Las-Peñas C, Cleland JA, Huijbregts P, Del Rosario Gutiérrez-Vega M. Short-term effects of cervical kinesio taping on pain and cervical range of motion in patients with acute whiplash injury: a randomized clinical trial. J Orthop Sports Phys Ther 2009;39:515-21.
33. Farina D, Arendt-Nielsen L, Merletti R, Graven-Nielsen T. Effect of experimental muscle pain on motor unit firing rate and conduction velocity. J Neurophysiol 2004;91:1250-9.
34. Bandholm T, Rasmussen L, Aagaard P, Diederichsen L, Jensen BR. Effects of experimental muscle pain on shoulder-abduction force steadiness and muscle activity in healthy subjects. Eur J Appl Physiol 2008;102:643-50.
35. Lin JJ, Hung CJ, Yang PL. The effects of scapular taping on electromyographic muscle activity and proprioception feedback in healthy shoulders. J Orthop Res 2011;29:53-7.
36. Słupik A, Dwornik M, Bia6oszewski D, Zych E. Effect of Kinesio Taping on bioelectrical activity of vastus medialis muscle. Preliminary report. Ortop Traumatol Rehabil 2007; 9:644-51.
37. Huang CY, Hsieh TH, Lu SC, Su FC. Effect of the Kinesio tape to muscle activity and vertical jump performance in healthy inactive people. Biomed Eng Online 2011;10:70.
38. Fu TC, Wong AM, Pei YC, Wu KP, Chou SW, Lin YC. Effect of Kinesio taping on muscle strength in athletes - a pilot study. J Sci Med Sport 2008;11:198-201.
39. Herrington L. The effect of patella taping on quadriceps strength and functional performance in normal subjects. Phys Ther Sport 2004;5:33-36.
40. Surenkok O, Aytar A, Baltaci G. Acute effects of scapular mobilization in shoulder dysfunction: a double-blind randomized placebo-controlled trial. J Sport Rehabil 2009;18: 493-501.