

COMBINED EFFECT OF THERAPEUTIC EXERCISES AND SHOCK WAVE VERSUS THERAPEUTIC EXERCISES AND PHONOPHORESIS IN TREATMENT OF SHOULDER IMPINGEMENT SYNDROME. A RANDOMIZED CONTROLLED TRIAL

By

¹Mashaly MM and ²El Shiwi AMF

¹Department of Basic Science, ²Department of Physical Therapy for Musculoskeletal Disorders and its Surgery, Faculty of Physical Therapy, Cairo University.

Abstract:

Introduction: Shoulder impingement syndrome is an encroachment of subacromial tissues, rotator cuff, subacromial bursa, and the long head of the biceps tendon, as a result of narrowing of the subacromial space. Activities requiring repetitive or sustained use of the arms over head often predispose the rotator cuff tendon to injury. **Aim of Work:** To compare between combined effects of Therapeutic Exercises and Shock Wave Therapy (SWT) versus Therapeutic Exercises and Phonophoresis in treatment of shoulder impingement syndrome. **Materials and Methods:** Thirty patients diagnosed as shoulder impingement syndrome stage II Neer classification due to mechanical causes. Patients were randomly distributed into two equal groups. The first group consisted of 15 patients with a mean age of 45.46 (± 8.64) received therapeutic exercises (stretching exercise of posterior shoulder capsule and strengthening exercises of shoulder muscles) and shockwave therapy (6000 shock, 2000/session, 3 sessions, 2 weeks a part, 0.22mJ/mm²) years. The second group consisted of 15 patients with a mean age of 46.26 (± 8.05) received same therapeutic exercises and phonophoresis (3 times per week, each other day, for 4 consecutive weeks). Patients were evaluated pretreatment and post treatment for shoulder pain severity, shoulder functional disability, shoulder flexion, abduction and internal rotation motions. Results: Patients of both groups showed

significant improvement in all the measured variables. In between groups difference the shock wave group showed a significant improvement in all measured variables than phonophoresis group. Conclusion: combined effect of therapeutic exercises and shock wave were more effective than therapeutic exercises and phonophoresis on decreasing shoulder pain severity, shoulder functional disability, increasing in shoulder flexion, abduction and internal rotation in patients with shoulder impingement syndrome.

Keywords: Shoulder Impingement Syndrome, Therapeutic Exercises, Shockwave, phonophoresis.

Introduction

Shoulder impingement syndrome (SIS) is an encroachment of subacromial tissues, rotator cuff, subacromial bursa, and the long head of the biceps tendon, as a result of narrowing of the subacromial space. It is one of the major causes of shoulder pain and may lead to functional disability and reduction in quality of life (Erol et al., 2008).

Impingement syndrome or rotator cuff syndrome of the shoulder is a common disorder. The cumulative incidence of shoulder complaints in general practice is estimated to be 11.2/1000 patients per year, the impingement being the most frequent recorded disorder (Bang and Deyle, 2000)

Activities requiring repetitive or sustained use of the arms over head often predispose the rotator cuff tendon to injury. There are two reasons for this biomechanical trauma:(1)

mechanical impingement of the subacromial structures against the anterior acromion and coracoacromial ligament when the arm is lifted over head especially in abduction and flexion with the arm internally rotated and (2) hypovascularity of the rotator cuff tendons in this region (Richardson and Iglarsh, 1999)

Physical therapy modalities and exercises can be listed as the most common treatment for shoulder pain (Arsian and Celiker, 2001). Exercises and muscle stretching are effective means of treating shoulder dysfunction and enhancing range of motion in patients with shoulder impingement (Conory and Hayes, 1998).

Shock waves are sound waves that are generated by a source that creates vibration which are then transported through tissue via fluid and solid particles interaction (Perez et al., 2003). It has been used for the treatment of numerous musculoskeletal disorders,

including calcified tendonitis of shoulder, lateral epicondylitis, achilles and patellar tendinopathies, chronic planter fasciitis, osteonecrosis of the femoral head, and delayed union and non union of fractures (Furia, 2006)

The rationale for the use of shock wave for these conditions is based on stimulation of soft tissue healing by local hyperemia, revascularization, reduction of calcifications, inhibition of pain and denervation to achieve pain relief and persistent healing of chronic inflammatory process (Maier et al., 2002). Side effects are usually minimal, and may include local bruising or short duration swelling and tenderness (Lebrun, 2005).

Phonophoresis is the migration of drug molecules through the skin under the ultrasound transducer head (Hsieh, 2006). The medication gel or cream could be used. It is clear that both ultrasound and exercises are common modalities for the management of skeletal muscle injury and often used in attempt to augment repair and regeneration of muscle tissue (Markert et al., 2005).

Aim of Work

To compare between combined effect of therapeutic exercises and shock wave versus therapeutic exercises and phonophoresis on pain, functional disability and shoulder range of motion in patients with shoulder impingement syndrome.

Materials and Methods

This study was conducted in the outpatient clinic of physical therapy, National Institute of Neuromotor System, Imbaba, Giza, Egypt, and outpatient clinic of physical therapy, Elsahel Teaching Hospital, Cairo, Egypt.

1-Subjects:

Participants were identified and recruited over 9-month period. Thirty six patients diagnosed clinically as shoulder impingement syndrome (according to location of trigger points at rotator cuff muscles and aggravation of pain with over head activities) were examined for eligibility in the study (Figure: 1)

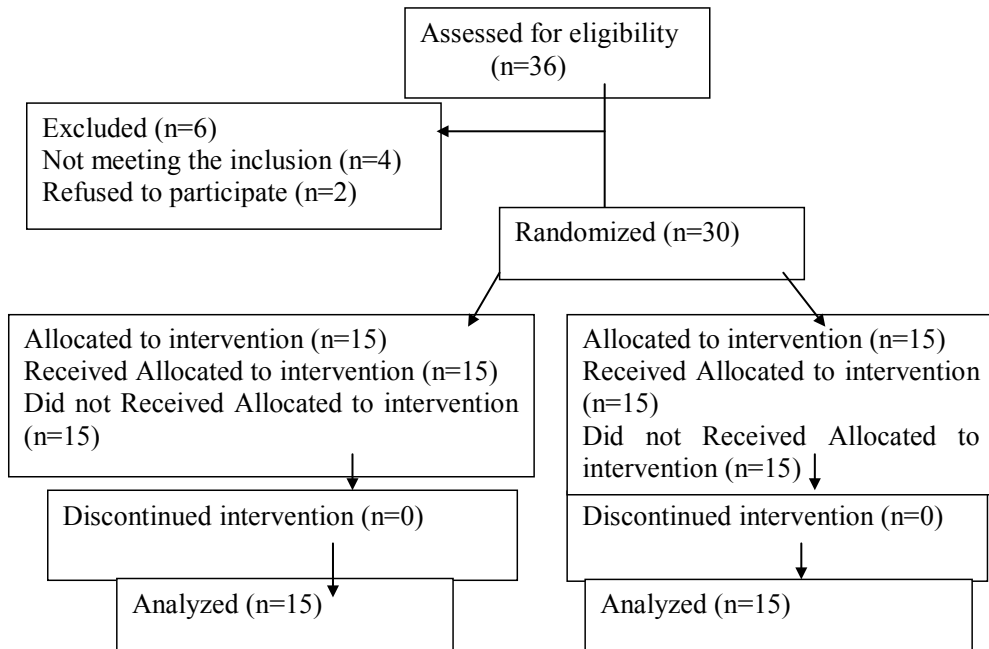


Figure 1: Participants flow diagram

Inclusion criteria:

- The patient reported a positive “Neer sign” and” Hawkins sign”.
- The patient reported pain with active shoulder elevation in the scapular plane (eg: welders, plate workers, slaughterhouse workers and over head playing athletes).
- The patient reported pain with palpation of the rotator cuff tendons.
- The patient reported pain with resisted isometric abduction.

Exclusion criteria:

- Frozen shoulder.
- Rotator cuff tear.
- Glenohumeral or acromioclavicular arthritis.
- Implanted pace maker.
- Pregnancy

The experiment continued with 30 patients (18 female and 12 male), their age ranges from 30 to 50 years signed an informed consent. The subjects were assigned randomly (one by one

for each group) into: Group (A): 15 patients received therapeutic exercises (stretching exercise of posterior shoulder capsule and strengthening exercises of shoulder muscles) and shockwave therapy (6000 shock, 2000/session, 3 sessions, 2 weeks a part, 0.22mJ/mm²) years. Group (B): 15 patients received same therapeutic exercises and phonophoresis (3 times per week, each other day, for 4 consecutive weeks).

2- Instrumentation:

(A) Assessment instrumentations:

Patients were assessed before and after the treatment sessions by:

1. Visual analogue scale.
2. Shoulder pain and disability index (SPADI).
3. Electro Goniometer.

- Assessment procedures

- 1- Pain assessed by Visual analog scale (VAS). VAS is a scale that allows continuous data analysis and uses a 10cm line with 0 (no pain) and 10 (worst pain) on the other end. Patients were asked to place a mark along the line to denote their level of pain.
- 2- Pain and functional disability were assessed by using the shoulder

pain and disability index (SPADI) which is a valid and reliable index for measuring shoulder pain and disability. It consists of two parts, part one which assesses pain and part two which assesses functional disability. Scores were calculated as follow, in part one pain scores in all questions were added, and the mean value was chosen. In part two functional score of all questions were added and the mean value was chosen for the purpose of data analysis. Final score for each part was statistically analyzed separately (Roddey et al. 2000).

- 3- Range of motion assessment: In this study the shoulder flexion, abduction and internal rotation were measured by using (Model 01129 Guymon goniometer). It is an electrogoniometer which eliminates the need of manually score each measurement by storing the information internally, it reduces time. It measures any joint angle quickly and accurately. It has range of 0 to 360 and stores up to 80 data points. The validity and reliability of electrogoniometer for shoulder assessment was tested and well documented (Christian, 1999).

The device was calibrated before assessment.

(a) Shoulder flexion range of motion was measured by using the standard universal goniometer with the fulcrum on the acromial process, movable arm parallel to the lateral border of the arm and the fixed arm was parallel to the bed. Patient was in the supine lying position and the tested arm was in the mid position patient was instructed to lift his arm up as much as he could. This was done for three consecutive times and the mean was calculated and used for the purpose of data analysis.

(b) Shoulder abduction range of motion was measured by using the standard universal goniometer with the fulcrum on the coracoid process, movable arm parallel to the anterior surface of the arm and the fixed arm was parallel to the clavicle. Patient was in supine lying position and the tested arm was in the mid position. Patient was instructed to abduct his arm away from his body as much as he could. This was done for three consecutive times and the mean

was calculated and used for the purpose of data analysis.

(c) Shoulder internal rotation range of motion was measured by using the standard universal goniometer with the fulcrum placed on the olecranon process, the movable arm was parallel to the ulnar border of the forearm while the fixed arm was parallel to the bed. Patient was in supine lying position and the tested arm was 90° shoulder abduction with elbow flexed 90° and forearm pronated. This was done for three consecutive times and the mean was calculated and used for the purpose of data analysis.

(B) Treatment Instrumentation:

a- Shock wave therapy:

Radial extracorporeal shock wave device, it is serial number (1107394), Medispec and connected to electrical supply 115/220 A C frequency.

b- Ultrasound:

Pagani ultrasound apparatus 200 consists of multi frequency head (1 and 3 MHz), surface area 4 cm², continuous and pulsed mode, main voltages: 100-240-VAC.50/60Hz.

Treatment procedures:**Group (A):****1- Therapeutic exercises:**

They were received 12 sessions, 3 session/week, consisted of:

- a- Stretching exercise of posterior shoulder capsule: It was a passive stretching exercise for the posterior shoulder capsule and surrounding musculature. This single exercise was done for only 3 times with a holding time 30 seconds and 10 seconds rest period between repetitions (Bang and Deyle, 2000).
- b- Strengthening exercises: consists of 6 strengthening exercises all of which have been recommended as essential for any shoulder rehabilitation program. These exercises included shoulder flexion, scaption, rowing, and horizontal extension for each of the exercises, 10- repetition maximum was determined. This determination was based on the examiner's observation of movement quality and the subject's responses with regard to fatigue and pain. Deterioration in movement quality or pain exceeding a mild discomfort was avoided during all strengthening exercises by either reducing the level

of resistance or modifying the ROM until the subject was able to progress. Each exercise was performed as 3 set of 10 repetitions with a 60- second rest period between each set.

The remaining 2 exercises are the seated press-up and the elbow push up. Both were performed to fatigue or for a maximum of 25 repetitions. The quality of all repetitions of each exercise was continuously monitored by the investigator of the study. This standardized program was based on work of (Bang and Deyle, 2000).

2- Shock wave:

All patients were received Extracorporeal Shock Wave Therapy (ESWT) at sitting position, exposed the affected shoulder, the shoulder adducted and elbow extended and the shock wave applicator was directed in most tender point near the insertion of rotator cuff at greater tuberosity under the acromion (Cacchio, 2006).

The treatment area was prepared with a coupling gel to minimize the loss of shockwave at the interface between applicator tip and skin.

Each patient was received (6000 shocks, 21000 shock/ session, 3 session 2 weeks apart, energy flux density 0.22

mJ/mm², energy level 5-7, pulse rate 160/min., 2-3Hz)

Group (B):

- 1- Therapeutic exercises: Same as group (A).
- 2- Phonophoresis: Continuous mode ultrasound with frequency of 3MHz and intensity 1w/cm was applied on the affected shoulder at the site of pain using diclofenac sodium gel for 5 minute.

Statistical analysis

Data obtained from the study was coded and entered using the statistical package SSPS. Descriptive statistics for demographic data and all out come measures were expressed as mean and standard deviation .Comparisons between groups were done using unpaired t- test. Comparison between groups was done using paired t- test. P values less than 0.05 and 0.01 were considered statistically significant.

Results

Demographic data of patients

A total of 30 male and female patients participated in this study; they were randomly assigned into two groups: experimental group I and experimental group II. The experimental group I consisted of 15 patients (6 males and 9 females) with mean age of 45.33 (\pm 8.64) years and mean duration of illness of 1.83 (\pm 0.54) months, this group was treated by therapeutic exercises and shock wave therapy. The experimental group II consisted of 15 patients (5 males and 10 females) with mean age of 46.26 (\pm 8.05) years and mean duration of illness of 1.96 (\pm 0.69) months; this group was treated by therapeutic exercises and phonophoresis. Unpaired t-test showed that there was no significant difference between groups before treatment (Table 1):

Table 1: Demographic data of patients

Variables	Shockwave Group I	Phonophoresis Group II	t-value	p-value
Age (year)	45.33 (\pm 8.64)	46.26 (\pm 8.05)	-0.3	0.76(N.S)
Duration of illness (Month)	1.83 (\pm 0. 54)	1.96 (\pm 0.69)	0.50	0.62(N.S)

NS: Non Significant

Comparison between groups before treatment

Unpaired t test was used to detect differences between groups before treatment. There was no significant difference between groups regarding pain severity ($t=0.14$, $P= 0.88$), functional disability ($t= 0.26$, $P= 0.46$), shoulder flexion ($t= -1.01$, $P= 0.98$), abduction ($t=-0.06$, $P= 0.94$) and internal rotation ($t=-0.41$, $P= 0.68$) as shown in Table (2).

Table 2: Comparison between shockwave group and therapeutic exercise group before treatment

Variables	Shockwave Group (I)	Phonophoresis Group (II)	t-value	P-value
Pain severity	6.8 (\pm 1.08)	6.73 (\pm 1.38)	0.14	0.88 (N.S)
Functional disability	6.86 (\pm 0.91)	6.6 (\pm 1.05)	0.26	0.46 (N.S)
Flexion	109.86 (\pm 23.35)	110.79 (\pm 21.38)	-1.01	0.98 (N.S)
Abduction	100.26 (\pm 7.02)	100.53(\pm 13.51)	-0.06	0.94 (N.S)
Internal rotation	29.33 (\pm 5.64)	28.26(\pm 3.86)	0.41	0.68 (N.S)

NS: Non Significant

Comparison between groups after treatment:

Unpaired t test was used to detect differences between groups after treatment. There was significant difference between groups in favor of shockwave group regarding pain severity ($t=-2.55$, $P= 0.01$), and in favor of therapeutic exercises group regarding functional disability ($t= 4.11$, $P= 0.001$), shoulder flexion ($t= -8.10$, $P= 0.001$), abduction ($t=-3.84$, $P= 0.001$) and internal rotation ($t=-4.83$, $P= 0.01$) as shown in Table (3).

Table 3: Comparison between shockwave group and phonophoresis group after treatment

Variables	Shockwave Group (I)	Phonophoresis Group (II)	t-value	P-value
Pain severity	0.4 (± 0.05)	1.06 (± 0.7)	-2.97	0.006*
Functional disability	0.6 (± 0.5)	1.2 (± 0.67)	-2.75	0.01 *
Flexion	173.53(± 6.41)	159.33 (± 13.47)	8.91	0.001 *
Abduction	174.33 (± 5.21)	162.2 (± 12.49)	3.47	0.002 *
Internal rotation	44.4 (± 0.73)	42.73 (± 2.12)	2.87	0.01 *

*: Significant

Discussion

Shoulder impingement syndrome is one of the most common disorders of the shoulder due to mechanical compression of the rotator cuff and subacromial tissue underneath the coracoacromial arch due to frequent or sustained overhead use of the arm in certain occupations or sports.

All patients in both groups had symptoms of shoulder impingement syndrome, this agrees with Koster et al.,

(2005) who reported that patients with shoulder impingement syndrome report pain localized to the antero lateral acromion and frequently radiates to the lateral mid humerus, patients usually complain of pain at night, exacerbated by lying on the involved shoulder or overhead activity.

From the findings of the current study the combined effect of therapeutic exercises and shockwave are more effective interventions

to reduce shoulder pain severity, functional disability and to increase shoulder flexion, abduction, internal rotation than therapeutic exercises and phonophoresis,

1- Therapeutic exercises:

The improvement may be attributed to the effect of therapeutic exercises used in this study in the form strengthening exercises to the shoulder joint muscles and stretching of the posterior shoulder capsule.

This finding has been supported by (Senbursa et al. 2007; Michener et al. 2004; Bang and Deyle 2000 and Mayers et al. 2006) and Senbursa et al. (2007) who concluded that manual physical therapy applied by experienced physical therapist combined with supervised exercises might be better than exercises alone for increasing strength, decreasing pain, and improving function in patients with impingement syndrome.

Michener et al. (2004) found by a systemic review that exercises and joint mobilizations were efficacious for decreasing pain and improving function for patients with shoulder impingement syndrome. These results supported the use of therapeutic exercises and mobilization in treating shoulder impingement syndrome patients.

Bang and Deyle, (2000) detected that manual physical therapy combined with supervised shoulder exercises is superior to supervised shoulder exercises alone for improving strength, function and reducing pain in patients with shoulder impingement syndrome.

Mayers et al. (2006) deduced that tightness of the posterior elements of the shoulder (capsule, rotator cuff) may contribute to impingement, therefore management should include stretching to restore flexibility to the posterior shoulder capsule to correct the shoulder arthrokinematics so helping in improving shoulder motions and function.

A simple 6 week exercise program aimed at strengthening the rotator cuff, increasing the flexibility of the posterior glenohumeral capsule, and encouraging upper thoracic extension and a retracted head position have resulted in improved muscle force, motion, pain, and function in a group of patients with shoulder impingement (Mcclure et al., 2004).

2- Shock wave:

The reduction in pain severity ,improvement of function and range of motion for shoulder impingement syndrome patients after shock wave

therapy could be attributed to it has positive anti-inflammatory effect, antibacterial effect, neovascularization due to increase nitric oxide (NO) level and interruption the flow of nerve impulses.

These results come in agreement with (Hsu et al., 2008; Pan et al., 2003; Cacchio et al., 2006 and Charri and Noel 2001).

Hsu et al., (2008) reported that ESWT showed pain relief for rotator cuff tendinitis of the shoulder. Pan et al., (2003) stated that visual analog scale (VAS) improved after ESWT treatment to tendinitis of the shoulder.

Cacchio et al., (2006) showed significant reduction in shoulder pain after 4 weeks of treatment by SWT. Charrin and Noel, (2001) reported that pain severity decreased after treatment of thirty two patients with rotator cuff calcific tendinitis received SWT.

The analgesic effect of SWT could be attributed to the following mechanisms: Shock waves induced analgesic effect by over stimulating the axons (gate-control theory) thereby increasing a person pain threshold (Rompe et al., 2001).

Other hypothesized mechanisms of action include the physical alteration of small axons, therapy inhibiting pain impulse conduction, and chemical alteration of pain receptors neurotransmitter, thereby preventing pain perception (Malay et al., 2006).

Following a certain number of shock waves, it is likely that endorphins are released locally which cause decrease of pain (Tassery and Allaire, 2003).

ESWT cause reduction of substance P in the target tissue in conjunction with reduced synthesis of this molecule in dorsal root ganglia cells as well as by selective destruction of unmyelinated nerve fibers in the focal zone of ESW (Schmitz, 2010).

Hyper stimulation of nociceptors and interruption the flow of nerve impulses could lead to pain alleviation (Zimmermann et al., 2009).

ESW has anti inflammatory effect by maintenance of proper amount of nitric oxide (NO) contribute to contrast the cytokine-elected NF-KB activation and successive induction of NF-KB – depend antigens (Ciampa et al., 2005), it also attenuates acute pro-inflammatory cytokine expression and extra cellular matrix proteolytic activity (Davis et al., 2009).

These results also come in agreement with Arno et al., (2010) who reported that (SW) increases perfusion in ischemic tissues, stimulate growth factors, decreases inflammation, accelerate healing, enhances polymorph nuclear neutrophils and macrophage infiltration and have antibacterial effect.

It is able to increase neovascularization as well as reduce muscle tone and spasticity (Zimmermann et al., 2009).

Wang et al., (2003) concluded that SWT induced the growth of neovascularization which play a role to improve blood supply and tissue regeneration at bone tendon junction.

3- Phonophoresis:

From statistical analysis there was a significant improvement in all parameters of pre and post values of group (B) but less than group (A) this may be attributed to the therapeutic effect of phonophoresis. These results was in agreement with (Byl, 1995; Mcdiarmid, 1996; Gam and Johansen, 1995; and Wells et al., 1996).

Topical applied drugs can include local and systemic effect, the drugs entered the capillary network by ultrasound, became systemic, and then

returned to the local area through the blood stream (Byl, 1995). Ultrasound used to enhance percutaneous absorption of anti-inflammatory drugs and local analgesics, this technique termed phonophoresis (Mcdiarmid, 1996).

Gam and Johansen, (1995) stated that the biological effect of ultrasound include: enhanced blood flow, increased membrane permeability, nerve conduction and stimulation of protein synthesis.

Wells et al.,(1996) stated that the thermal effect of ultrasound alter the skeletal muscles contractile process directly, decrease muscle spindle activity and relieve pain, resulting in decrease of skeletal muscle spasm.

Conclusion

From the findings of the current study we can conclude both that combined effect of therapeutic exercises with shockwave, and therapeutic exercises with phonophoresis are effective interventions to reduce shoulder pain severity, functional disability and to increase shoulder flexion, abduction, and internal rotation motions in treatment of patients with shoulder impingement syndrome. However,

combined effect of therapeutic exercises and shockwave were more effective than therapeutic exercises and phonophoresis in treatment of shoulder impingement syndrome patients.

Recommendations

Researches should be conducted to compare between SWT and other electrotherapy like, TENS and laser in treatment of shoulder impingement syndrome.

1. Studying the efficacy of (SWT) in treatment of other orthopedic like osteoarthritis, patello femoral pain syndrome and carpal tunnel syndrome.
2. Further studies are required to investigate the effect of (phonophoresis) in treatment of other shoulder joint disorders like frozen shoulder.
3. Further studies are required to determine long term effect of (SWT) in shoulder impingement syndrome.
4. Further studies are required to determine the potential adverse effects due to (SWT) application.

References

1. Arno A, Garcia O, Hernan I, Sancho J, Acosta A and Barret JP (2010): Extra corporeal shock waves a new non-surgical method to treat severe burns. *Burn*; 80 (25): 119-129.
2. Arsian S and Celiker R (2001): Comparison of the efficacy of local corticosteroid and physical therapy for the treatment of adhesive capsulitis. *Rheumatology Int*; 21: 20-23.
3. Bang M D, Deyle GD (2000): Comparison of supervised exercises with and without manual physical therapy for patients with shoulder impingement syndrome. *J Ortho Phys Ther*; 30:130-137.
4. Byl N (1995): The use of ultrasound as an enhancer for transcutaneous drug delivery. *Phys Ther*; 75: 590-600.
5. Cacchio A, Paoloni M, Barile A and Don R (2006): Effectiveness of radial shock wave therapy for calcific tendinitis of the shoulder: Single blind, randomized clinical study. *Physical therapy*; 86 (5): 672-680.
6. Charrin J and Noel E (2001): Shock wave therapy under sonography guidance in rotator cuff calcific tendonitis. *Joint Bone Spine*; 68 (3): 241-244.
7. Christian H (1999): Precision and accuracy of an electrogoniometer. *J manipulative physiother*; 22:10-14.
8. Ciampa AR, Prati AC, Amelio E, Cavalieri E, Persichini T, Colasanti M, Musci G, Marlinghaus E, Suruki H and Mariotto S(2005): Nitric oxide mediates anti-inflammatory action of extracorporeal shock waves. *FEBS letters* 579 (19): 6839-6845.
9. Conroy DE and Hayes KW (1998): The effect of joint mobilization as a component of comprehensive treatment for primary shoulder impingement syndrome. *J. Orthop. Sports Phys. Ther*; 28:3-14.
10. Davis TA, Stojadinovic A, Amare K, Anam M, Naik S, Peoples EE, Tadaki D and Elster EA (2009): Extra corporeal shockwave therapy suppresses the acute early pro inflammatory immune response to a severe cutaneous burn injury. *Int. Wound Journal*; 6: 11-21.
11. Erol O, Ozcakar L and Celiker R (2008): Shoulder rotator strength in patients with stage I-II subacromial impingement: Relationship to

- pain, disability, and quality of the life. *Journal of shoulder and elbow surgery*; 17 (6): 893-897.
12. Furia JP (2006): High energy extracorporeal shock wave therapy for insertional achillis tendinopathy. *Am J sports Med*; 34: 733-740.
 13. Gam A and Johannsen F (1995): Ultrasound therapy in musculoskeletal disorders. *Phys Ther*; 63:85-91.
 14. Hsieh Y (2006): Effect of ultrasound and diclofenac phonophoresis on inflammatory pain relief: suppression of inducible nitric oxide synthases in arthritic rats. *Physio Ther*; 86:39-49.
 15. Hsu C, Wang D, Tseng K, Fong Y, Hsu H and Jim Y(2008): Extra corporeal shock wave therapy for calcifying tendonitis of the shoulder. *Journal of shoulder and elbow surgery*; 17 (1): 55-59.
 16. Hurov J (2009): Anatomy and mechanics of the shoulder: Review of current concept. *Journal of Hand Therapy*; 22 (4): 328-343.
 17. Koester MC, George MS and Juhn JE (2005): Shoulder impingement syndrome. *The American Journal of Medicine*; 118 (5): 452-455.
 18. Lebrun C (2005): Understanding shock wave therapy for the treatment of bone and tendon pain. *Sportline*; 1 (20): 1-4.
 19. Maier M, Miler S, Writz DC, Rompe JD and Schrittr C (2002): Basic research of the applying extracorporeal shock waves on the musculoskeletal system. An assessment of current status. *Orthopedec*; 31: 667-677.
 20. Malay DS, Pressman MM, Assili A and Kline JT (2006): Extracorporeal shock wave therapy versus placebo for the treatment of chronic proximal fasciitis. *The journal of foot and ankle surgery*; 45 (4): 196-209.
 21. Makert JK, Thomas H and Yang B (2005): Therapeutic modalities in rehabilitation. Philadelphia, FA. Davis Company, 3rd ed p: 612-614.
 22. McClure PW, Bilker J, Neff N, Williams G, Karduna A (2004): Shoulder function and 3-dimensional kinematics in people with shoulder impingement syndrome before and after a 6-week exercise program. *Phys Ther*; 84: 832-848.
 23. Mediarimid T, Ziskin M and Michlovitz S (1996): Therapeutic and thermal agents in rehabilitation. Philadelphia, FA. Davis Company, 3rd ed; p: 168-212.
 24. Michener LA, Walsworth MK, Burnet EV (2004): Effectiveness of rehabilitation for patients with subacromial impingement syndrome a systematic review. *J Hand Ther*; 17(2): 152-164.
 25. Myers J B and Bradley JP (2006): Glenohumeral range of motion deficits and posterior shoulder Tightness in throwers with pathologic internal impingement. *Am J sport Med*; 34 (3): 385-391.
 26. Pan P, Chou C, Chiou H, Ma H, Lee H and Chan R (2003): extracorporeal shock wave therapy for chronic calcific of the shoulders: a functional and sonographic study. *Archives of physical medicine and rehabilitation*; 84 (7): 988-993.
 27. Perez M, Weiner R and Gilley JC (2003): Extracorporeal shock wave therapy for the planter facilities. *Clin. Pediatr. Med. Surg*; 20: 333-346, 2003.
 28. Richardson JK and Iglarsh ZA (1999): Clinical orthopedic physical therapy. WB Saunders Company, 2nd ed. (4): 194-196.
 29. Roddey TS, Olson SI, Cook KF (2000): Comparison of university of California Los Angeles shoulder scale and simple shoulder test with shoulder pain and disability index: single administration reliability and validity. *Phys Ther*; 80: 759-768.
 30. Rompe JD, Zoellner J and Nafe B (2001): Shock wave therapy versus conventional surgery in the treatment of calcifying tendonitis of the shoulder. *Clinical Orthopedics and Related Research*; 389: 72-82.
 31. Schmitz C (2010): Pain relief in sports medicine by radial extracorporeal shock wave therapy: An update on the current understanding. *Journal of science and medicine in sport*; 12 (2): e105.

32. Senbursa G, Balataci G, Atay A (2007): 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*; 15: 915-921.
33. Wang CJ, Wang FS, Yang KD, Weng LH, Hsu CC, Huang CS and Yang LC (2003): Shockwave therapy induces revascularization at the at the tendon-bone junction. A study in rabbits. *J Orthop Res*; 21: 984-989.
34. Wells P, Frampton V and Bowsher D (1996): *Pain management and control in physiotherapy*. New York, Churchill Livingstone. 6th ed; 136-150.
35. Zimmermann R, Cumanas A, Midea F and Janetschek G (2009): Extracorporeal shock wave therapy for the treatment of chronic pelvic pain syndrome in males: A randomized, Double-Blind Placebo-Controlled study. *European Urology*; 56 (3): 418-424, 2009.