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RESEARCH ARTICLE

EFFECTIVENESS OF SUBSCAPULARIS SOFT TISSUE MOBILIZATION VERSUS PROPRIOCEPTIVE NEUROMUSCULAR FACILITATION ON GLENOHUMERAL EXTERNAL ROTATION IN PERIARTHRITIS SHOULDER

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ABSTRACT

Objectives: To compare the effect of subscapularis soft tissue mobilization and proprioceptive neuromuscular facilitation on glenohumeral external rotation in periarthritis shoulder.
Design: Comparitive study of quasi experimental design
Settings: The study was conducted in SRM Medical Hospital& Research Center, Kattankulathur.
Procedure: Subjects diagnosed with periarthritis shoulder are divided into two groups, the treatment for one group was given with subscapular soft tissue mobilization and other with proprioceptive neuromuscular facilitation on glenohumeral external rotation.
Results: There was significant difference in subscapular soft tissue mobilization and proprioceptive neuromuscular facilitation on glenohumeral external rotation on periarthritis shoulder between the groups P<0.000.
Conclusion: The study concluded that there was a significant reduction of pain and improvement of glenohumeral external rotation range of motion of both groups.

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INTRODUCTION

Periarthritis (PA) is often a "catch-all diagnosis" that can imply many shoulder problems (Hazleman, 1972). Periarthritis of shoulder is one of the common affliction of shoulder joint affecting as much as 2% of the general population (Vijay *et al*., 2003). It is most common in the 40-60 year old age group. Periarthritis means inflammation of the tissues surrounding a joint and functional disturbance of periarticular tissues; tendons, ligaments, and synovial bursae (Hauzer, 2004). Some of the more common terms that are synonymous to periarthritis of the shoulder are adhesive capsulitis, frozen shoulder, stiff and painful shoulder, scapulohumeral periarthritis, tendonitis of short rotators, adherent subacromial bursitis (Bruce *et al*., 2001). Grubbs defined frozen shoulder as "soft tissue capsular lesion accompanied by painful and restricted active and passive motion at the glenohumeral joint" (Hazleman, 1972). Neviaser in 1946 surgically explored periarthritis shoulder cases, finding absence of the glenohumeral synovial fluid and the redundant axillary fold of the capsule, as well as the thickening and contraction of the capsule, which had become adherent to the humeral head, thus, he used the term "Adhesive Capsulitis" (Neviaser, 1945). Over the past few decades, shoulder impingement syndrome has become an increasingly common diagnosis (Uthoff and Sarkar, 1991). Neer described subacromial impingement syndrome as a distinct clinical entity and hypothesized that the rotator cuff is impinged upon by the anterior one third of the acromion, the coracoacromial ligament and the acromioclavicular joint rather than by merely the lateral aspect of the acromion. They also suggested that the part of the rotator cuff that is impinged upon is at the insertion of the supraspinatus tendon on the greater tuberosity (the impingement zone). Subacromial impingement is a condition that belongs to the group of diseases known collectively as periarthritis humeroscapularis (Rupp and Fritsch, 1995). According to Barnbeck and Hierholzer (1991) the functional and anatomical consideration of shoulder joint in relation to the clinical aspects can differentiate the general term of scapulohumeral periarthritis. The most frequent pathological findings are seen in the rotator cuff and long head of biceps muscle, which further leads to frozen shoulder (Barnbeck and

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Hierholzer, 1991). Therefore periarthritis humero scapularis simplex which includes tendinitis of the subacromial structures can be considered to be the early onset of periarthritis. This has been supported by Fabis and Zwierzchowski (1996) who reports that "Impingement syndrome" is characteristic of periarthritis humeroscapularis simplex (Fabis and Zwierchowski, 1996). Hannafin and Chiaia *et al*. (2000) described four phases of periarthritis of shoulder through the assistance of arthroscopic study (Hanaffin and Chiaia, 2000).

Stage 1

- Duration of symptoms 0-3 months.
- Pain with active and passive range of motion.
- Limitation of external rotation and abduction.
- Arthroscopy: Diffuse glenohumeral synovitis, often more pronounced in the anterosuperior capsule.

Stage 2 "Freezing stage"

- Duration of symptoms 3-9 months.
- Chronic pain with active and passive range of motion.
- Significant limitation of forward flexion, abduction, internal rotation, and external rotation.
- Arthroscopy: Diffuse pedunculated synovitis, tight capsule with rubbery or dense feel on insertion of arthroscope.

Stage 3 "Frozen stage"

- Duration of symptoms 9-15 months.
- Minimal pain except at end the range.
- Significant limitation of range of motion with rigid "end feel"
- Arthroscopy: No hypervascularity seen, remnant of fibrotic synovium can be seen. The capsule feels extremely dense and thick on insertion of arthroscope and there is a diminished capsule volume.

Stage 4 "Thawing stage"

- Duration of symptoms 15-24 months.
- Minimal pain.
- Progressive improvement in range of motion.

Early periarthritis or periarthritis humero scapularis simplex presents with the pain and limitation of movement as their primary symptoms. The movements limited in case of periarthritis are predominantly abduction, external rotation and internal rotation which is the capsular pattern. Reeves based on the arthrokinematics of shoulder motion, follows that the external rotation would be more limited than internal rotation (Reeves, 1966). External rotation is important for complete range of motion of upper extremity and hence rehabilitation of external rotation of shoulder in these patients is essential for restoring their activities of daily living. According to the classification published by Hedtmann *et al*. a simple, an adhesive, a calcifying, and a destructive periarthritis humero scapularis should be distinguished (Hedtmann and Fett, 1989). Glenohumeral external rotation becomes more limited as humerus moves towards 90° of abduction, suggestive of glenohumeral capsular restriction (Ovesen and Neilsen, 1985). However a patient who has a greater limitation of glenohumeral external rotation at 45° of abduction when compared to the available external rotation at 90° abduction may have a subscapularis muscle flexibility deficit rather than a glenohumeral capsular restriction in early periarthritis. It has been reported in a study that subscapularis muscle flexibility deficit is responsible for glenohumeral external rotation restriction at 45° of abduction (Godges Joseph *et al*., 2003). The common limiters of glenohumeral external rotation are the glenohumeral capsule and the shoulder internal rotators (Ovesen and Neilsen, 1985). Anatomically it is confirmed that subscapularis tendon is intraarticular component of glenohumeral joint capsule (Pearsall *et al*., 2000). A shortened subscapularis muscle has been implicated as a cause of limited motion in patients diagnosed with adhesive capsulitis (Bruce H. Greenfield and Brain J. Tovin, 2001). Cadaver studies and outcomes of subscapularis release suggest that subscapularis muscle flexibility deficits are responsible for glenohumeral external rotation limitation in lower ranges of abduction (MacDonald *et al*., 1992). Myofascial trigger points in the shoulder girdle muscle can initiate periarthritis of shoulder. This is especially true when subscapularis muscle is involved. Guarding of this muscle will restrict abduction and external rotation. Inflammation of the subscapularis bursa (bursitis) may also cause the subscapularis muscle to go into guarding. It is interesting to note that an irritation or entrapment of the lower subscapular nerve which innervates the subscapularis and teres major muscle will produce muscle guarding at the shoulder that will restrict external rotation, abduction, or flexion (Donatelli Robert, 1997). Therefore, it is seen that subscapularis muscle is involved in shoulder impingement syndrome and it is responsible for restricting the shoulder external rotation movement at lower ranges of abduction. It implies that subscapularis muscle is involved in early periarthritis of shoulder.

The normal procedures of treatment for periarthritis shoulder shoulder include giving emphasis on increasing Range of Motion (ROM) of the shoulder (Donatelli Robert, 1997). Most of the treatment modalities in this include mobilizations, active exercises and reducing the inflammatory process by giving ultrasound. Mobilizations are seen to be helpful in increasing joint range of motion of the shoulder in periarthritis shoulder (Donatelli Robert, 1997). Active exercises, like shoulder wheel, Codman's exercises, overhead pulleys and finger ladder exercises help in maintaining the joint range of motion at the shoulder (Kisner Carolyn and Colby Lynn Allen, 1995). According to literature, Proprioceptive Neuromuscular Facilitation (PNF) movement patterns helps in activating the agonist muscles and at the same time stretching the antagonist muscles so that they activate a stronger contraction and hence stronger movement. And it also stretches the capsule while the movement is done in diagonal pattern and hence helps out in increasing joint range of motion (Donatelli Robert, 1997; Knott Margaret and Voss Dorothy, 1968). Joshi and Kotwal advocated graduated relaxed sustained stretching based on the PNF patterns, which may increase in the range of motion of the shoulder (Joshi and Kotwal, 1999). Contract-relax PNF procedures have been shown to be effective in increasing range of motion (Etnyre and Abraham, 1986; Markos, 1979; Wallin *et al*., 1985). Trigger points and tender, taut bands in muscles have been recognized for centuries dating back to the time of Hippocrates (Kostopoulos and Rizopoulos, 2001). Soft tissue mobilization is the application of specific and progressive manual forces with the intent of promoting changes in the myofascia, allowing for elongation of shortened structures.[16] Trigger points are characterized by local tenderness on

palpation and by pain on contraction of the muscle. Common sites for trigger points around the shoulder include all of the rotator cuff, latissimus dorsi, teres major, deltoids and the pectoral muscles (Kostopoulos and Rizopoulos, 2001; Travell and Simons, 1983). Treatment of these tender areas of muscles by soft tissue manipulation has been proposed by several authors to improve the viscoelastic properties of the muscle and thus in turn improve the biomechanics of shoulder motion, resulting in less pain and improved function (Cohen *et al*., 1998; Hunter, 1998). Soft tissue mobilization (STM) techniques can release trigger points and allow the muscle to function normally. Manual treatment of the soft tissues has existed since the beginning of recorded history in the form of massage and manipulation (Johnson and Saliba-Johnson, 1992). The primary purpose of these approaches was apparently to treat symptomatic soft tissues. The functional orthopaedics approach to soft tissue mobilization has been developed not only to evaluate and treat soft tissue dysfunctions that precipitate myofascial pain, but also to evaluate and treat those dysfunctions that alter structure and function and produce mechanical strains upon symptomatic structures (Johnson and Saliba-Johnson, 1992).

Aim of the study

To compare the effectiveness of subscapularis soft tissue mobilization versus proprioceptive neuromuscular facilitation in glenohumeral external rotation when measured at 45° of abduction in patients with periarthritis shoulder.

Need for the study

Soft tissue mobilization and proprioceptive neuromuscular facilitation were either used as adjunctive treatment with conventional physiotherapy in the management of patients with periarthritis shoulder by the physiotherapists to improve the external rotation of the shoulder. Thus the need of the study is to find whether soft tissue mobilization or proprioceptive neuromuscular facilitation is the best adjunctive treatment for the patients with periarthritis shoulder in improving the external rotation of the shoulder.

Methodology: Study design was quasi-experimental, type of the study was comparative study with 30 subjects of age group 40-60 years, sampling method was convenient sampling of 3 weeks duration, the study was done at SRM Medical College, Hospital& Research Institute, Kattankulathur.

Inclusion criteria: Patients diagnosed with periarthritis shoulder by a physician.

Apley's Scratch Test positive.

- Gender- Male and Female
- Age between 40-60 years.
- Pain in the shoulder joint with restriction of glenohumeral external rotation more in the lower ranges of abduction that is at 45 degrees of abduction.
- Duration of symptoms between 3-9 months.

Exclusion criteria

- Any surgical procedures of shoulder joint within 12 months.
- Rheumatoid arthritis.
- Any trauma to the shoulder and post mobilization.
- Subjects whose available glenohumeral external rotation decreased as the humerus was abducted to 90 degrees will be presumed to have capsular restrictions.
- Any prior physiotherapy treatment for this condition.

Materials used

- Goniometer
- Paper
- Marker pen
- Scale
- Couch
- Pillow
- Wax bath unit

Procedure

30 Subjects were included in the study after they met the inclusion and exclusion criteria. Informed consent was obtained from each subject. Then the subjects were randomly allocated into two groups (Group A and Group B) of 15 members each.

Pre-test measures

1) Glenohumeral external rotation range of motion:

Standard Goniometer was used to measure the passive range of glenohumeral external rotation with the shoulder at 45° of abduction. The patients were asked to lie supine on treatment table with a pillow under their knees. A point was marked on the skin over the olecrenon process and a reference line was drawn on the skin over the ulnar aspect of forearm. A roll of towel was kept under the elbow to maintain shoulder in neutral and to prevent extension at shoulder. The shoulder was maintained at 45° of abduction and elbow at 90° of flexion. The patient arm was passively externally rotated through the available pain free range of motion. The external rotation was measured in degrees using standard goniometer with its stationary arm parallel to treatment table and moving arm in line with reference line on forearm. This measurement was taken twice, once at the beginning of the study (pre test) and another one at the end of the study (post test).

2) Shoulder Pain and Disability Index :- (Annexure- 3)
Group – A (Wax Therapy, Pendular Exercise and Subscapularis Soft Tissue Mobilization)

All the patients of this group received wrapping method of wax therapy for 8-10 min with a temperature maintained at 40°- 45° celsius. Wax was applied in and around the shoulder. Pendular exercises were asked to perform for 10 repetitions in each set and with total of 2 sets. This was followed by subscapularis soft tissue mobilization.

Pendular exercises

Participants were positioned with the non-affected arm resting on a table and the affected upper extremity hanging down for free movement. In the gravity assisted plane the patient was made to do:

a) Flexion and extension
b) Abduction and adduction
c) Clockwise and counterclockwise circular rotation

Soft tissue mobilization of subscapularis muscle

Patients were made to lie supine on the treatment table with arm approximately abducted to available pain free range. With the elbow flexed to 90°, the humerus was externally rotated to a midrange position about of external rotation. Therapist stood by the side the patient's shoulder. One hand was placed just above the lateral border of the scapula in axillary region and the other hand was used to stabilize the patient arm. Subscapularis muscle was palpated by going deep till reaching anterior aspect of scapula. The identification of the muscle was confirmed by feeling the contraction when the patient internally rotated the shoulder. On palpation of subscapularis muscle, trigger points or taut bands was located. The trigger points were then treated with soft tissue mobilization using ischemic compression technique. The pressure was applied over the trigger points by using index and middle finger perpendicular to the plane of muscle. Having confirmed the trigger points by "Jump sign" or characteristic pattern of referred pain distant from the point of contact the applied pressure was increased till pain occurs (pain threshold) and was maintained for 60 seconds and the procedure was repeated only once (Knott Margaret and Voss Dorothy, 1968).

Group–B (Wax Therapy, Pendular Exercise and Proprioceptive Neuromuscular Facilitation)

All the patients in this group received wax therapy and pendular exercises as in Group – A. This was followed by contract-relax proprioceptive neuromuscular facilitation once daily for 10 times in each set and 2 sets for each session.

Proprioceptive Neuromuscular Facilitation (PNF) Technique

Contract-relax PNF is used to improve the glenohumeral external rotation. It was given to the subscapularis and other glenohumeral medial rotators. Patient was in the same position as positioned in Soft Tissue Mobilization. The patients were instructed to perform maximal glenohumeral internal rotation against an opposing, isometric, maximum manual resistance applied by the physical therapist for 7 seconds. Afterwards, the patient actively moved the humerus into full available external rotation. This position was maintained for 15 seconds. This 7 second internal rotation contraction against resistance followed by full active external rotation was repeated for 5 times. Subjects were then instructed to actively move through the PNF flexion-abduction external-rotation diagonal pattern for 5 repetitions with manual

Post-test Measures

The following dependent variables were measured before the intervention and immediately after three weeks of intervention:-

Glenohumeral external rotation range of motion, at 45° of abduction measured by goniometer.

Pain and functional outcome measured by Shoulder Pain and Disability Index (SPADI) facilitation.

RESULTS

Group A: The significance of pre& post-test glenohumeral external rotation and SPADI score is P<0.00.

Group B: The significance of pre& post-test of glenohumeral external rotation and SPADI score is P<0.00.

Conclusion

Thus the results of this study conclude that there was a significant reduction of pain and improvement of glenohumeral external rotation range of motion of both groups. Comparatively there was more reduction of pain and improvement of glenohumeral external rotation range of motion in subjects who received wax therapy, pendular exercise and subscaplaris soft tissue mobilization than those who received wax therapy, pendular exercise and proprioceptive neuromuscular facilitation. Thus subscapularis soft tissue mobilization along with wax therapy and pendular exercise is effective in improving glenohumeral external rotation range of motion in patients with periarthritis shoulder.

Limitations

- The study duration was short.
- The sample size was small.
- This study is done only in 40-60 years of age groups.
- Muscle power were not taken as outcome measures.

Recommendations

- This study can be done with larger sample size.
- Same study can be done in sports specific population.
- Same study can be done in different body weights.
- Long term effects of mobilization can be studied.

REFERENCES

Bajaj, P., Graven-Nielsen, T. and Arendt-Nielsen, L. 2001. Trigger points in patients with lower limb osteoarthritis. *J Musculoskeletal Pain*, 9(3):17-33.

Barnbeck, F. and Hierholzer, G. 1991. Analysis of collective term periarthritis humeroscapularis. *Aktuelle Traumatol*., 21(2): 49-52.

Barnbeck, F. and Hierholzer, G. 1991. Analysis of collective term periarthritis humeroscapularis. *Aktuelle Traumatol*., 21(2): 49-52.

Borrell, R.M., Parker, R., Henley, E.J., Masley, D. and Repinecz M. 1980. Comparison of in vivo temperatures produced by hydrotherapy, paraffin wax treatment and fluidotherapy. *Phys Ther*., 60:1273–1276.

Brent Brotzman. S. 1996. Clinical orthopedic rehabilitation. Mosby.

Bruce, H. Greenfield and Brain, J. Tovin, 2001. Evaluation and treatment of the Shoulder. An integration of the guide to physical therapist practice. Philadelphia F.A.Davis.

Caplan, N., Rogers, R., Parr, M. K. and Hayes, P. R. 2009. The effect of proprioceptive neuromuscular facilitation and static stretch training on running mechanics. *Journal of Strength & Conditioning Research*, 23:1175-1180.

Caroit, M., Saumarmon, P. and Ryckewaert, A. 1978. Contribution to the study of scapulohumeral periarthritis, anatomical lesions of simple chronic painful shoulder. *Rev Rheum Mal Osteoarthritic*., 45(6): P 389-93.

Cohen, J, Gibbons, R. and Raymond, L. Nimmo, 1998. The evolution of trigger point therapy. *Journal of Manipulative and Physiological Therapeutics*, 21:167-172.

Donatelli Robert, A. 1997. Physical Therapy of the Shoulder. New York; Churchill Livingstone, p- 109.

Duplay, Rizk TE and Pinals RS. 1982. Frozen Shoulder. *Semin Arthritis Rheum*., 11: P 440.

Enwemeka, C. S. 1986. Radiographic verification of knee goniometry. *Scand J Rehabil Med*., 18:47.

Etnyre BR. and Abraham LD. 1986. Gains in range of ankle dorsiflexion using three popular stretching techniques. *Am J Phys Med*., 65:189-196.

Fabis J. and Zwierchowski H. 1996. Analysis of clinical symptoms in shoulder arthropathy. *Chir Narzadow Ruchu Orthop*., 61(2): 133-7.

Fernández-de-Las-Peñas C, Alonso-Blanco C, Fernández-Carnero J. and Miangolarra-Page JC. 2006. The immediate effect of ischemic compression technique and transverse friction massage on tenderness of active and latent myofascial triggers points: a pilot study. *J Bodyw Mov Ther*., 10:3-9.

Fishbain DA, Goldberg M, Meagher BR. *et al*. 1986. Male and female chronic pain patient's catogerised by DSM-111 psychiatric diagnostic criteria. *Pain*, 26:181-97.

Fricton J, Auvinen M, Dykstra D and Schiffman E. 1985. Myofascial pain syndrome: electromyographic changes associated with local twitch response. *Archives of Physical Medicine and Rehabilitation*., 66:314-317.

Gajdosik RL. 2001. Passive extensibility of skeletal muscle: review of the literature with clinical implications. *Clinical Biomechanics*, 16:87-101.

Gam A, Warming S, Larsen L, Jensen B, Hrydalsmo O, Allon I, Andersen B, Grtzsche N, Petersen M. and Mathiese B. 1998. Treatment of myofascial trigger-points with ultrasound combined with massage and exercise – a randomised controlled trial. *Pain*, 77:73-79.

Godges Joseph J, Melodie Mattson-Bell, Thorpe Donna *et al*. 2003. The Immediate Effects of Soft Tissue Mobilization with Proprioceptive Neuromuscular Facilitation on Glenohumeral External Rotation and Overhead Reach. *J Orthop Sports Phys Ther*., 33:713-718.

Grosshandler S, Stratas N, Toomey T and Gray W. 1985. Chronic neck and shoulder pain: focusing on Myofascial origins. *Chronic Pain*, 77:149-158.

Guissard, N., Duchateau, J. and Hainaut, K. 1988. Muscle stretching and motoneuron excitability. *European Journal of Applied Physiology and Occupational Physiology*, 58:47-52.

Hanaffin JA. and Chiaia TA. 2000. Adhesive capsulitis: a tratement approach. *Clin Orthop*., 372: P 95-109.

Hauzer JP. 2004. Conservative treatement of painful shoulder. Review of literature. *Rev Med Brunx*, 25(4): P 411-5.

Hazleman BL. 1972. The painful stiff shoulder. *Rheumatology Phys Med*., 11:413.

Hedtmann A. and Fett H. 1989. So-called humero-scapular periarthropathy – classification and analysis based on 1,266 cases. *Z Orthop Ihre Grenzgeb*., 127:643-649

Hong C. and Simons D. 1998. Pathophysiological and electrophysiological mechanisms of myofascial trigger points. *Archives of Physical Medicine and Rehabilitation*, 79: 863-872.

Hunter G. 1998. Specific soft tissue mobilisation in the management of soft tissue dysfunction. *Manual Therapy*, 3:2-11.

Johnson GS and Saliba-Johnson VL. 1992. Functional Orthopaedics 1: Course Outline. The Institute of Physical Art, San Anselmo, CA.

Joshi and Kotwal, 1999. Essentials of Orthopaedics and Applied Physiotherapy, Churchill Livingstone, 473-477.

Kisner Carolyn and Colby Lynn Allen, 1995. Therapeutic Exercise, Foundations and Techniques, 3rd Edition, Jaypee Brothers.

Knott Margaret and Voss Dorothy, 1968. Proprioceptive Neuromuscular Facilitation, Patterns and Techniques, 2nd Edition, Harper and Low.

Knudson, D. 1998. Stretching: from science to practice. *Journal of Physical Education, Recreation & Dance*, 69(3):38-42.

Kostopoulos D and Rizopoulos K. 2001. The Manual of Trigger Point and Myofascial Therapy. New Jersey: Slack Incorporated, pp. 3-5, 106-125.

MacDermid, *et al*. 1999. Validity of pain and motion indicators recorded on a movement diagram of shoulder lateral rotation*J Hand Therapy*, 12:187-192.

MacDonald PB, Hawkins RJ, Fowler PJ. and Miniaci A. 1992. Release of the subscapularis for internal rotation contracture and pain after anterior repair for recurrent anterior dislocation of the shoulder. *J Bone Joint Surg Am*., 74(5): 734-7.

Markos PD. 1979. Ipsilateral and contralateral effects of proprioceptive neuromuscular facilitation techniques on hip motion and electromyographic activity. *Phys Ther*., 59:1366-1373.

McCann PD, Wootten MF, Kadaba MP. and Bigliani LU. 1993. A kinematic and electromyographic study of shoulder rehabilitation exercises. *Clin Orthop Related Research*, 288:179-88.

Miller M, Wirth M. and Rockwood C. 1996. Thawing the frozen shoulder: The "patient" patient. *Orthopedics*, 19:849–853.

Neviaser JS. 1945. Adhesive capsulitis of the shoulder. Study of pathological findings in periarthritis of shoulder. *J Bone Joint Surg*., 27: P-211.

Ovesen J. and Neilsen S. 1985. Stability of the shoulder joint. Cadaver study of stabilizing structures. *Acta Orthop Scand*., 56(2):149-51.

Pearsall AW 4th, Holovacs TF. And Speer KP. 2000. The intra-articular component of the subscapularis tendon: anatomic and histological correlations in reference to surgical release in patients with frozen-shoulder syndrome. *Arthroscopy*, 16(3):236-42.

Reeves B. 1966. Arthrographic changes in frozen shoulder and post-traumatic stiff shoulders. *Proc. Soc. Med*., 59:827.

Refior HJ. 1995. Clarification of the concept humeroscapular periarthritis Orthopade, 24(6): P 509-11.

Rizk TE. and Pinals RS. 1982. Frozen Shoulder. *Semin Arthritis Rheum*., 11: P 440.

Roy JS, MacDermid JC. and Woodhouse LJ. 2009. Measuring shoulder function: a systematic review of four questionnaires. *Arthritis Rheum*., 61(5):623-632.

Rupp S. and Fritsch E. 1995. Subacromial imoingement. Evaluating the concept-diagnosis- therapeutic concepts. *Fortchr Med*., 113(15):223-6.

Simons DG. 1996. Clinical and etiological update of myofascial pain from trigger points. *J Musculoske Pain*, 4(1/2):93-121.

Surburg, P. R. and Schrader, J. W. 1997. Proprioceptive neuromuscular facilitation techniques in Sports Medicine: a Reassessment. *Jounal of Athletic Training*, 32:34-39.

Travell J and Simons D. 1983. Myofascial Pain and Dysfunction, the Trigger Point Manual: Volume 1: The Upper Extremities. Baltimore: Williams and Wilkins.

Uthoff HK. and Sarkar K. 1991. Classification and definition of tendinopathies. *Clin Sports Med*., 10(4): 707-20

Vijay B, Durgas Sakalkale and Russel F Warren, 2003. The role of capsular distention in adhesive capsulitis. *Arch Phys Med & Rehab*., 84: P 1290-1292.

Wadsworth, C.T. 1988. The shoulder. In: Butler, J.P. (Ed.), Manual Examination and Treatment of the Spine and Extremities. Williams & Wilkins, Baltimore.

Wallin D, Ekblom B, Grahn R. and Nordenborg T. 1985. Improvement of muscle flexibility. A comparison between two techniques. *Am J Sports Med*., 13:263-268.

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