Central European Journal of Sport Sciences and Medicine | Vol. 42, No. 2/2023: 85–94
ISSN (print): 2300-9705 | ISSN (online): 2353-2807 | DOI: 10.18276/cej.2023.2-08

IMMEDIATE EFFECTS OF KINESIO-TAPING AND JOINT MOBILISATION ON SHOULDER IN OVER-HEAD ATHLETES WITH GLENOHUMERAL INTERNAL ROTATION DEFICIT

Amrinder Singh[A]
MYAS- GNDU Department of Sports Sciences and Medicine, Guru Nanak Dev University, Amritsar, Punjab, India
ORCID: 0000-0002-0378-8476 | e-mail: amrindersinghpt@gmail.com

Yogini Makhijani[B]
MYAS- GNDU Department of Sports Sciences and Medicine, Guru Nanak Dev University, Amritsar, Punjab, India
ORCID: 0000-0001-6857-2169

Monika Sharma[C]
MYAS- GNDU Department of Sports Sciences and Medicine, Guru Nanak Dev University, Amritsar, Punjab, India
ORCID: 0000-0002-4344-2533

Shweta Shenoy[D]
ORCID: 0000-0001-5091-5784
MYAS- GNDU Department of Sports Sciences and Medicine, Guru Nanak Dev University, Amritsar, Punjab, India

Jaspal Sandhu[E]
MYAS- GNDU Department of Sports Sciences and Medicine, Guru Nanak Dev University, Amritsar, Punjab, India

[A] Study Design; [B] Data Collection; [C] Statistical Analysis; [D] Manuscript Preparation; [E] Funds Collection

Abstract The purpose of this study was to compare efficacy of kinesio taping (K-taping) and joint mobilization as immediate interventions for treating athletes with glenohumeral internal rotation deficit (GIRD). Thirty-two asymptomatic players were recruited from basketball, volleyball and handball who had a loss of shoulder internal rotation range of motion (IR ROM) of 10 degrees or more on their dominant compared to non-dominant side. They were randomly assigned to 1 of 2 groups: K-taping (n = 16) or joint mobilization (n=16). Participants in taping group were treated with K-tape for inhibition of external rotators of shoulder and participants in joint mobilization group were treated with grade four Maitland's mobilization technique for increasing glenohumeral internal rotation. Shoulder internal and external ROM were measured before and after the intervention with a universal goniometer. Both the methods produced significant improvement in IR ROM. The unpaired t-test showed significant change in IR ROM within both the groups (p = 0.003). No significant change was found on comparing both the groups (p = 0.373). There were no significant differences between results of the three sports (p = 0.592). K-taping and joint mobilization both are equally effective in improving the IR ROM in over-head players with GIRD.

Key words: kinesio taping, joint mobilization, GIRD, over-head athletes

Introduction

The glenohumeral joint (GHJ) is a ball and socket synovial joint consisting of the articulation between the head of humerus and glenoid fossa. The glenohumeral joint has sacrificed articular congruency to increase the mobility of the upper extremity and hand and is therefore susceptible to degenerative changes, instability and derangement (Levangie & Norkin, 2005). Players in overhead sports are required to perform repeated overhead movements and the glenohumeral joint must achieve extremes of range of motion, velocities and forces across the arc of movement (Dillman et al., 1993).

When the dominant arm is abducted 90 degrees, the GHJ external rotation ROM of the dominant arm is usually much greater than the nondominant arm (Borsa et al., 2008)thus exposing the overhead athlete to shoulder injury. Debate continues as to whether these altered mobility patterns arise from soft-tissue or osseous adaptations within and around the shoulder. Researchers have used quantitative techniques in an attempt to better characterize these structural adaptations in the shoulders of overhead athletes. Throwing athletes have been shown to display altered rotational range of motion (ROM. However, the total arc of motion (TAM) (the sum of maximum GHJ external and internal rotation ROM at 90° of abduction) does not always differ bilaterally. When compared to the nondominant shoulder, IR and TAM in the dominant shoulder may be reduced as a result of repetitive throwing. This leads to alteration in the GHJ arthrokinematics (Kibler et al., 2012). This loss of GH IR ROM at 90° of abduction in the dominant shoulder compared to the non-dominant shoulder is referred to as glenohumeral internal rotation deficit or GIRD. It can be as little as 10 degrees to as high as 25 degrees of deficit. According to research, overhead athletes with a shoulder IR limitation of ≥25 degrees have a 4 times higher chance of shoulder or elbow pain and injury, while those with a limitation of ≥10 degrees had a 2 times higher risk (Shanley et al., 2011).

It has been noted that overhead throwing athletes can expect a gain in external rotation and decreased internal rotation. It is most common in repetitive overhead throwing for the posterior shoulder musculature or ligamentous and capsular structures to become tight. This tightness can decrease an individual's ability to horizontally adduct the glenohumeral joint as well as impede internal rotation. Repetitive throwing can induce microtrauma to the ligaments in the posterior shoulder, making them more rigid and limiting movement (Mine et al., 2017).

The infraspinatus muscle contributes significantly to compressive forces at the glenohumeral joint and along with the rotator cuff muscles, serves an important role of being a static and dynamic stabilizer of the glenohumeral joint (Choi et al., 2017). Measurements of muscle activity indicate that the infraspinatus begins to become highly active at ball release, and the activity level remains elevated throughout the follow-through phase (Kotoshiba et al., 2021). Due to repetitive use of the external rotators of the shoulder: infraspinatus and teres minor in overhead throwing, the muscles are prone to over activity and muscle tightness resulting in possible reduction in internal rotation and increased external rotation.

Posterior-inferior GHJ capsule is hypothesized to become hypertrophied in over-head athletes due to the repetitive tensile stress placed on it during the arm deceleration and follow-through phase of throwing, creating a large force for the posterior shoulder to counteract. A tight posterior capsule is therefore one potential mechanism of shoulder impingement as it causes excessive anterior translation of the humeral head and minimize the subacromial space with consequent instability of the capsule (Rose & Noonan, 2018).

There were considerable amount of research findings addressing various interventions for treating GIRD in athletes. However, majority of them are focused on stretching the posterior structures. Keeping in mind the necessary adaptations which take place in an overhead throwing athlete's shoulder for them to perform optimally, the purpose of this study is comparison of immediate effects of K-taping for fascia unloading and end range joint mobilisation for optimizing the arthrokinematic gliding and rolling movement of humeral head on overhead athletes with GIRD.

The need for this study stems from having taken into consideration the extremely common occurrence of GIRD in overhead players which makes them susceptible to shoulder injuries. Hence to find out immediate effectiveness of K-taping and joint mobilization on these players which can be practiced before their training or competition.

Material and Methods

Subjects

Thirty-two healthy male and female overhead athletes (height: 171.6 ±11.2 cm, weight: 75 ±5.6 kg, age: 21.2 ±5.6 years) volunteered for this study from Guru Nanak Dev University, Amritsar, Punjab. Institutional ethical committee approval was taken. A written consent form was taken by the subjects and the procedure was explained to them. Inclusion criteria included players with at least one year experience and are having a GIRD of minimum 10 degrees in the dominant arm. The players with a history of surgery or traumatic injury to the shoulders, if part of any rehabilitative exercise program for the shoulder joint or currently undergoing any prophylactic medical treatment were excluded from this study.

Procedure

Players were selected based on the inclusion and exclusion criteria. Independent variables in this study included age, level of participation, and dominant hand i.e., the arm used by the player to perform overhead activity in his sport. Dependent variable in this study was IR ROM. The measurement of IR and ER ROM of both the dominant and non-dominant arm with a universal goniometer (ISICO, Transparent, 360°) was carried out pre-intervention and post-intervention. players presenting with GIRD were selected to be a part of the study. To measure the shoulder rotation ROM the player was instructed to lie down supine on a firm plinth or bench with the shoulder in 90 degrees abduction and the elbow at 90 degrees flexion at the edge of the plinth and the goniometer was placed on the olecranon process. Three readings of ER and IR ROM were taken for both the arms and the average was calculated. After the assessment, the subjects were randomly divided into two groups, group A was treated with joint mobilization and group B was treated with K-tape.

Kinesio-Tape

Players were treated with K-tape for inhibition of external rotators of the shoulder: infraspinatus and teres-minor from insertion to origin with 15–25% stretch applied to the tape. All taping procedures were followed as described in Clinical Therapeutic Application Kinesio® Taping Manual 2nd edition. The subject was instructed to expose the required area and told to be in sitting position with his dominant shoulder and elbow flexed 90 degrees, internally rotated and horizontally adducted so as to apply a stretch on the external rotators. For inhibition of infraspinatus the tape was applied from its insertion: middle facet of greater tubercle of the humerus to the origin: infraspinous fossa of the scapula. For inhibition of teres minor the tape was applied from insertion: inferior facet of greater tubercle of the humerus to origin: lower $1/3^{rd}$ of lateral border of the scapula. After tape application the subject was to sit in resting position and ER and IR ROM was checked again.

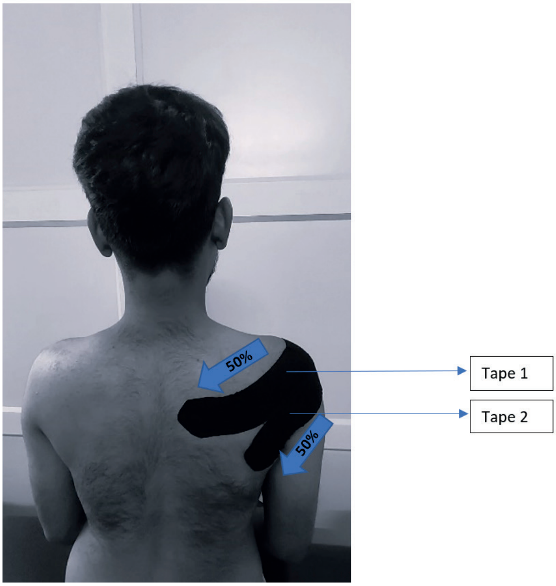


Figure 1. Demonstration of K-taping (posterior view) – Tape 1: Inhibition of Infraspinatus muscle and Tape 2: Inhibition of Teres Minor muscle

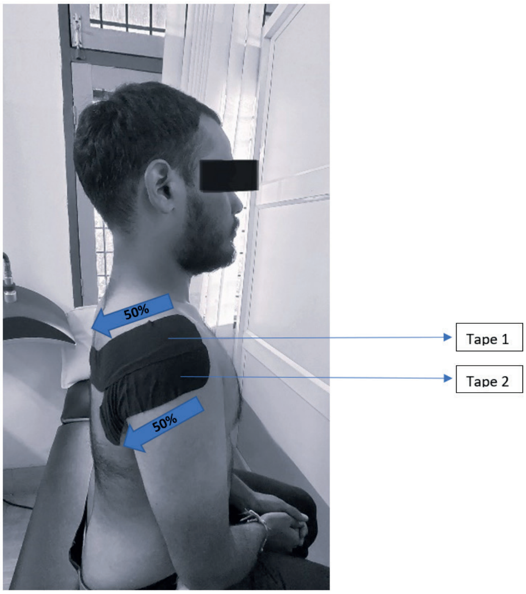


Figure 2. Demonstration of K-taping (lateral view) – Tape 1: Inhibition of Infraspinatus muscle and Tape 2: Inhibition of Teres Minor muscle

Joint Mobilization

Players were given end range GH antero-posterior (A-P) joint mobilization. Subject was positioned in supine with GHJ in loose pack position which is 55 degrees abduction, 30 degrees horizontal adduction and scapula stabilized. For the GHJ, Maitland's grade IV posterior glide mobilization was performed (small-amplitude rhythmic oscillations performed at the limit of the available motion and stressed into the tissue resistance). The 10 minutes intervention comprised 30 second mobilizations followed by 30 second rests. IR and ER ROM was checked again following 3 minutes rest after completion of intervention.

Figure 3. Demonstrating grade-IV A-P joint mobilization of GHJ

Statistics

The data was analysed using the SPPS software (version 16). Unpaired t-test was used to calculate the result between the two groups. Equal variances were assumed. The statistical significance was set at 95% confidence interval.

Results

The participants mean GH IR ROM for the throwing shoulder was 42.7 ±9.1 degrees and for the non-throwing shoulder was 57.3 ±8.5 degrees. The participants exhibited less GH IR ROM in the throwing shoulders as compared to the non-throwing shoulders. Both the methods produced significant improvement in IR ROM. Equal variances were assumed. According to the unpaired t-test significant change in IR ROM was found within both the groups ($p = 0.003$).

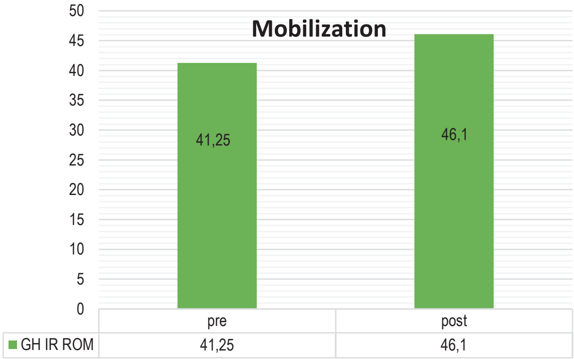
Table 1. Comparison of pre and post intervention data within the groups. Statistically significant association at $p \leq 0.05$

Groups	Pre-intervention IR ROM (mean ±SD)	Post-intervention IR ROM (mean ±SD)	t-value	p-value
Taping	42.7 ±9.1	45.1 ±7.6	3.266	0.003
Mobilization	41.26 ±11.8	46.1 ±5.6	3.266	0.003

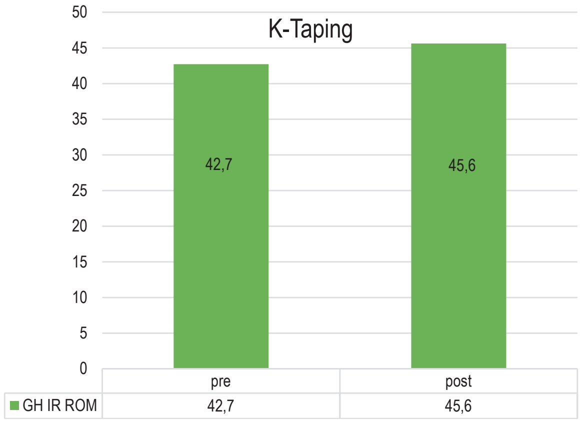
Table 2. Comparison between the two treatment groups. Statistically insignificant association at $p \geq 0.05$

Groups	IR ROM	P-value
Taping	45.6	0.373
Mobilization	46.1	

Graph 1. Comparison between post intervention IR ROM values for taping and mobilisation



Graph 2. Comparison between pre and post intervention ROM values for mobilization



Graph 3. Comparison between pre and post intervention ROM values for K-taping

Discussion

The over-head players in this study presented with a difference of 15.3 ±8.5 degrees less GH IR ROM in the dominant shoulders as compared to the non-dominant shoulders. This decreased range of GH IR is significant because players exhibiting GIRD of 10 degrees or more in the dominant shoulder as compared to the non-dominant shoulder are at a higher risk of injury and surgeries (Wilk et al., 2011). GIRD has been associated with posterior shoulder tightness mainly of the capsule, muscles, and ligaments. During the deceleration phase, there is a repetitive micro trauma to the posterior-inferior capsule which causes its contracture and thickening (Dashottar & Borstad, 2012). Osseous changes in the humeral head's centre of rotation also contribute to GIRD.

This study demonstrated improvements in GH IR ROM on the dominant side in both: taping and mobilization groups, but the difference between the groups was not statistically significant. The dominant shoulder joint in players had a GIRD of 15.3 ±8.5 degrees. Increment in internal rotation following the intervention were seen in both groups, which is in consensus with previous research concluding that internal rotation deficit is responsive to conservative treatments (Keramat & Babur, 2021) Mansehra, in 6-months duration. This quasi-experimental study recruited 120 young subjects with an equal proportion of males and females for four novel intervention groups (n = 30 each group

End range joint mobilization is a widely accepted intervention for improving range of motion of a restricted joint. Grade 1 distraction followed by end range joint mobilization for the glenohumeral joint was performed as intervention for treating GIRD in this study. The results demonstrate that joint mobilization technique significantly increased the glenohumeral IR ROM (p = 0.003) corroborating with previous literature (Yang et al., 2012) (Lin et al., 2008). Previous studies concluded that the end-range mobilization technique improves the flexibility of the glenohumeral joint capsule and stretches the soft tissue to induce an effect (Lin et al., 2008). Moreover, posterior gliding mobilization plays a role in normalizing the glenohumeral joint kinematics to ensure the humeral head glides in the appropriate direction (Manske et al., 2010).

The results of group B displayed an improvement in internal range of motion of shoulder (p = 0.003), (t = 3.266). Possible factors contributing to this include inhibition of muscles achieved by fascia unloading. The fascia surrounding a muscle group which is involved in repetitive activity can undergo thickening and shortening of the superficial and deep fascia in order to provide more stability and allow the muscle to generate more power (Day & Venter, 2009). The ability of the endofascial collagen fibres to slide over one another would alter due to changes in the extracellular matrix of the deep fascia, such as those brought on by overuse syndromes, strain, and repetitive stress injuries. This would result in a change in stiffness. In addition to the mechanical or tensional reaction, a possible alteration in afferent signals is also to be noted (Day et al., 2009a) different hypotheses concerning the function of this resilient tissue have led to the formulation of numerous soft tissue techniques for the treatment of musculoskeletal pain. This paper presents a pilot study concerning the application of one such manual technique, Fascial Manipulation, in 28 subjects suffering from chronic posterior brachial pain. This method involves a deep kneading of muscular fascia at specific points, termed centres of coordination (cc. Ten times as many sensory nerve receptors are present in the fascial network as in red muscular tissue (van der Wal, 2009). This includes various different types of sensory receptors, including the myelinated proprioceptive endings (Golgi, Paccini, and Ruffini endings), but also the many tiny unmyelinated 'free' nerve endings which are found almost everywhere in fascial tissues (Themes, 2016).

The objective of K-taping is to facilitate muscle relaxation. When applying K-tape, the body segment is Sccplaced in a stretched position, so that return to a normal resting position will create skin convolutions. The lifting of skin is thought to promote subcutaneous blood flow and lymphatic drainage as well as unload the underlying fascia, allowing the underlying muscle to relax and possibly reduce their pain, however, In this study we included only asymptomatic athletes. K-tape can potentially affect the deep fascia layers (Day et al., 2009b) different hypotheses concerning the function of this resilient tissue have led to the formulation of numerous soft tissue techniques for the treatment of musculoskeletal pain. This paper presents a pilot study concerning the application of one such manual technique, Fascial Manipulation, in 28 subjects suffering from chronic posterior brachial pain. This method involves a deep kneading of muscular fascia at specific points, termed centres of coordination (cc which might reduce the susceptibility to microtearing of the tissue (Schleip et al., 2010). It may facilitate improved performance, especially in sports that require repetitive high-intensity muscular efforts and eccentric loading (O'Sullivan & Bird, 2011).

The effectiveness of sleeper and cross body stretching has already been proven to increase the IR ROM in several studies (Joseph & A.v, 2013) (Tawfik et al., 2022). However inadequate lengthening achieved by regularly performing the slow and sustained stretches increases the risk of fascia tearing (O'Sullivan & Bird, 2011). The use of K-tape in our study has not only eliminated this disadvantage but also produced significant improvements in the IR ROM. This is because it lifts the skin and fascia in order to release the underlying muscle and increase the strength of muscle contractility (Baker et al., 2011) as opposed to increasing its length, which due to its viscoelastic and thixotropic properties (Stecco et al., 2020) makes it highly prone to microtears when stretched quickly (e.g., high-intensity eccentric loading during the arm deceleration and follow through phases of throwing) (Jeswani et al., 2009)including plantar fasciitis, plantar fascia rupture, plantar fibromatosis, and plantar xanthoma, and illustrate them with appropriate magnetic resonance imaging (MRI).

Similar change in ROM was found on comparing both the techniques in our study ($p = 0.373$) which hence proves that an application of joint mobilization is equally effective to K-taping and can be used to improve IR ROM in overhead athletes with GIRD.

This current study was purely focused on interventional strategies for improving the passive internal rotation of the affected glenohumeral joint and the possible presence of suprascapular nerve injury would not alter the outcome of this study also there is lack of evaluation of shoulder muscles major limitation of the study.

Conclusions

As there is a possible association between GIRD and shoulder injuries, improving the GIRD may help in reducing the susceptibility to such injuries including internal impingement, scapular dyskinesia, SLAP lesions and UCL injuries of the elbow. This study concludes that both the techniques are equally effective in improving the IR ROM in over-head players with GIRD. A combination of both the treatment techniques can also be used for a better result and injury prevention as both are equally effective and act on separate structures. Therefore, before training or competition if a player has limited time, K-tape can be applied on the shoulder and if additional time is available then combined K-taping and shoulder mobilization can be given to the player by the therapist.

References

Baker, C., Laiderman, B., Paunicka, E., Simpson, R., & Weaver, R. (2011). The effect of tape application to fascial planes on muscle contraction. Name of the publishing house.

Borsa, P. A., Laudner, K. G., & Sauers, E. L. (2008). Mobility and stability adaptations in the shoulder of the overhead athlete: A theoretical and evidence-based perspective. *Sports Medicine (Auckland, N.Z.)*, *38*(1), 17–36. https://doi.org/10.2165/00007256-200838010-00003

Choi, W.-J., Yoon, T.-L., Choi, S.-A., Lee, J.-H., & Cynn, H.-S. (2017). Different weight bearing push-up plus exercises with and without isometric horizontal abduction in subjects with scapular winging: A randomized trial. *Journal of Bodywork and Movement Therapies*, *21*(3), 582–588. https://doi.org/10.1016/j.jbmt.2016.08.018

Dashottar, A., & Borstad, J. (2012). Posterior glenohumeral joint capsule contracture. *Shoulder & Elbow*, *4*(4), 10.1111/j.1758-5740.2012.00180.x. https://doi.org/10.1111/j.1758-5740.2012.00180.x

Day, J. A., Stecco, C., & Stecco, A. (2009a). Application of Fascial Manipulation technique in chronic shoulder pain—Anatomical basis and clinical implications. *Journal of Bodywork and Movement Therapies*, *13*(2), 128–135. https://doi.org/10.1016/j.jbmt.2008.04.044

Day, J. A., Stecco, C., & Stecco, A. (2009b). Application of Fascial Manipulation technique in chronic shoulder pain—Anatomical basis and clinical implications. *Journal of Bodywork and Movement Therapies*, *13*(2), 128–135. https://doi.org/10.1016/j.jbmt.2008.04.044

de Witt, B., & Venter, R. (2009). The "Bunkie" test: Assessing functional strength to restore function through fascia manipulation. *Journal of Bodywork and Movement Therapies*, *13*(1), 81–88. https://doi.org/10.1016/j.jbmt.2008.04.035

Dillman, C. J., Fleisig, G. S., & Andrews, J. R. (1993). Biomechanics of pitching with emphasis upon shoulder kinematics. *The Journal of Orthopaedic and Sports Physical Therapy*, *18*(2), 402–408. https://doi.org/10.2519/jospt.1993.18.2.402

Jeswani, T., Morlese, J., & McNally, E. G. (2009). Getting to the heel of the problem: Plantar fascia lesions. *Clinical Radiology*, *64*(9), 931–939. https://doi.org/10.1016/j.crad.2009.02.020

Joseph*, J. K., & A.v, S. (2013). the immediate effects of sleeper stretcheson shoulder range of motion in volleyball players. *Innovative Journal of Medical and Health Sciences*, *3*(4), Article 4. http://innovativejournal.in/index.php/ijmhs/article/view/506

Keramat, K. U., & Babur, M. N. (2021). Comparison of the effectiveness of novel intervention on restricted range of motion of shoulder in young healthy subjects. *Pakistan Journal of Medical Sciences*, *37*(5), 1491–1498. https://doi.org/10.12669/pjms.37.5.3465

Kibler, W. B., Sciascia, A., & Thomas, S. J. (2012). Glenohumeral internal rotation deficit: Pathogenesis and response to acute throwing. *Sports Medicine and Arthroscopy Review*, *20*(1), 34–38. https://doi.org/10.1097/JSA.0b013e318244853e

Kotoshiba, S., Urabe, Y., Hara, M., Fujisawa, M., Sumida, R., Aramaki, K., Sasadai, J., & Maeda, N. (2021). The infraspinatus muscle activity during pitching motion in baseball players with shoulder instability. *JSES International*, *5*(3), 512–518. https://doi.org/10.1016/j.jseint.2020.12.013

Levangie, P. K., & Norkin, C. C. (2005). *Joint structure and function: A comprehensive analysis* (4th ed.). F.A. Davis Co.

Lin, H.-T., Hsu, A.-T., An, K.-N., Chang Chien, J.-R., Kuan, T.-S., & Chang, G.-L. (2008). Reliability of stiffness measured in glenohumeral joint and its application to assess the effect of end-range mobilization in subjects with adhesive capsulitis. *Manual Therapy*, *13*(4), 307–316. https://doi.org/10.1016/j.math.2007.02.003

Manske, R. C., Meschke, M., Porter, A., Smith, B., & Reiman, M. (2010). A Randomized Controlled Single-Blinded Comparison of Stretching Versus Stretching and Joint Mobilization for Posterior Shoulder Tightness Measured by Internal Rotation Motion Loss. *Sports Health*, *2*(2), 94–100. https://doi.org/10.1177/1941738109347775

Mine, K., Nakayama, T., Milanese, S., & Grimmer, K. (2017). Effectiveness of Stretching on Posterior Shoulder Tightness and Glenohumeral Internal-Rotation Deficit: A Systematic Review of Randomized Controlled Trials. *Journal of Sport Rehabilitation*, *26*(4), 294–305. https://doi.org/10.1123/jsr.2015-0172

O'Sullivan, D., & Bird, S. (2011). Utilization of Kinesio Taping for Fascia Unloading. *Athletic Therapy Today*, *16*, 21–27. https://doi.org/10.1123/ijatt.16.4.21

Rose, M., & Noonan, T. (2018). Glenohumeral internal rotation deficit in throwing athletes: Current perspectives. *Open Access Journal of Sports Medicine*, *9*, 69–78. https://doi.org/10.2147/OAJSM.S138975

Schleip, R., Klingler, W., & Zorn, A. (2010). Biomechanical Properties of Fascial Tissues and Their Role as Pain Generators. *Journal of Musculoskeletal Pain*, *18*, 393–395. https://doi.org/10.3109/10582452.2010.502628

Shanley, E., Rauh, M. J., Michener, L. A., Ellenbecker, T. S., Garrison, J. C., & Thigpen, C. A. (2011). Shoulder range of motion measures as risk factors for shoulder and elbow injuries in high school softball and baseball players. *The American Journal of Sports Medicine*, *39*(9), 1997–2006. https://doi.org/10.1177/0363546511408876

Stecco, C., Pirri, C., Fede, C., Yucesoy, C., Caro, R., & Stecco, A. (2020). Fascial or Muscle Stretching? A Narrative Review. *Applied Sciences*, *11*(1), 307. https://doi.org/10.3390/app11010307

Tawfik, A., Toci, G. R., Sirch, F., Gibbs, B., Conte, E., Fletcher, D., Hornstein, J., & Aland, C. (2022). The Effects of Sleeper and Superman Stretches on Time-Zero Shoulder Range of Motion in Collegiate Athletes. *Cureus*, *14*(2). https://doi.org/10.7759/cureus.22600

Themes, U. F. O. (2016, August 24). Fascia as an organ of communication. *Musculoskeletal Key*. https://musculoskeletalkey.com/fascia-as-an-organ-of-communication/

van der Wal, J. (2009). The architecture of the connective tissue in the musculoskeletal system-an often overlooked functional parameter as to proprioception in the locomotor apparatus. *International Journal of Therapeutic Massage & Bodywork*, *2*(4), 9–23. https://doi.org/10.3822/ijtmb.v2i4.62

Wilk, K. E., Macrina, L. C., Fleisig, G. S., Porterfield, R., Simpson, C. D., Harker, P., Paparesta, N., & Andrews, J. R. (2011). Correlation of glenohumeral internal rotation deficit and total rotational motion to shoulder injuries in professional baseball pitchers. *The American Journal of Sports Medicine*, *39*(2), 329–335. https://doi.org/10.1177/0363546510384223

Yang, J., Jan, M.-H., Chang, C., & Lin, J. (2012). Effectiveness of the end-range mobilization and scapular mobilization approach in a subgroup of subjects with frozen shoulder syndrome: A randomized control trial. *Manual Therapy*, *17*(1), 47–52. https://doi.org/10.1016/j.math.2011.08.006

Cite this article as: Singh, A., Makhijani, Y., Sharma, M., Shenoy, S., & Sandhu, J. (2023). Immediate Effects of Kinesio-taping and Joint Mobilisation on Shoulder in Over-head Athletes with Glenohumeral Internal Rotation Deficit, *Central European Journal of Sport Sciences and Medicine*, *2*(42), 85–94. http://doi.org/10.18276/cej.2023.2-08