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EFFECTIVENESS OF SCAPULAR STABILIZATION EXERCISES FOR SCAPULAR ASYMMETRY AMONG SWIMMERS USING LATERAL SCAPULAR SLIDE TEST: A EXPERIMENTAL STUDY

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ABSTRACT

BACKGROUND: Shoulder pain is particularly common among swimmers with up to 91% of swimmers.Ninety percent of the propulsive force in swimming comes from the upper extremity. The scapular asymmetry is alterations in scapular positioning which can have an effect on shoulder function. Scapular positioning has a direct relationship to shoulder stability.Asymmetry in scapular position between sides is often assumed as pathological.

OBJECTIVE: To evaluate the scapular stabilization exercises for scapular asymmetry as a factor causing shoulder pathology among swimmers using lateral scapular slide test.

METHOD: A experimental study has been undertaken. 50 swimmers have been selected randomly for the study and all swimmers are the members of Gandhi sports Swimming Society. Duration for the study is 8 weeks. The swimmers selected for the study are between the age group of 12-25 years within training sessions of minimum 6 times per week and 12 hours weekly. Subjects are excluded who has any shoulder pathology like fracture, surgery or any other traumatic injury.

RESULTS: The statistical analysis was carried out using ‘z test’ to determine the significance of correction of scapular asymmetry. There is no significant correction of asymmetry at 0 degree shoulder resting position and there is significant asymmetry in 45, 90 and135 degrees of shoulder abduction respectively.

CONCLUSION: Based on the statistical analysis, it is concluded that there is significant correction of scapular asymmetry found with the LSST test position at 45 degree, 90 degree and 135 degree. Also they may be characterized of having movement restriction of shoulder joint as well as shoulder pain in their later stage of life.

Abbreviations: LSST - Lateral scapular slide test.

Key words: Scapular asymmetry, Scapular stabilization exercises, Shoulder pain, Swimmers, Lateral scapular slide test.

1.INTRODUCTION

Swimming is an individual or team sport that requires the use of one's entire body to move through water. Swimming can be recreational, rehabilitation or a highly competitive sport which require high levels of training and performance. Swimmers begin their career earlier than a lot of other sports, typically at an age of 8 to 12 years.Usually, swimming represents a competitive overhead sport. Ninety percent of the propulsive force in swimming comes from the upper extremity.

Shoulder injuries frequently occur in swimming athletes: 47% to 80% of all competitive swimmers reported shoulder injuries6. Scapular positioning on the thoracic cage is a part of a comprehensive evaluation in patients with suspected shoulder dysfunction7. The scapula is vital in shoulder function and scapulohumoral rhythm and scapulothoracic rhythm. In swimming an athlete's scapular musculature also plays a pivotal role in stabilizing and maintaining strength of the shoulderjoint.

Physiologically, it is important in scapulohumoral rhythm, the coupled and coordinated movement between the scapula and the arm that allows placement of the arm in the optimum position and achievement of the proper motion to accomplish tasks. Biomechanically, the scapula provides a stable base for muscle activation and a moving platform to maintain ball and socket kinematics. It also serves as an efficient link between the core, which develops force, and the arm, which delivers the force.

The scapula is internally rotated 350 to 450 from the coronal plane, is tilted anteriorly approximately 100 to 150 from vertical, and is upwardly rotated 50 to 100 from vertical.The scapulothoracic joint is one of the least congruent joints in the body. No actual bony articulation exists between the scapula and the thorax, which allows tremendous mobility in many directions, including protraction, retraction, elevation, depression, and rotation10.The movement of the scapula on thorax contributes to 500 to 600 of the shoulder flexion and abduction. The glenohumoral joint contributes to 1000to 1200 of abduction. This combination of scapula and glenohumoral joint movement results in a maximum range of elevation 1500 to 1800 of shoulder joint. A number of studies have investigated that this rhythm with ratios reported varying between 1.25:1 and 2.69:1. This is called as the "scapulohumoral rhythm"

Asymmetry in scapular position between sides is often assumed as pathological. Asymmetries can affect both resistance and propulsion which, together with physiological capacity of the swimmer, are the key determinants of performance. It can affect resistance primarily through their effect on shape and posture. On affecting propulsion include uneven contributions by right and left upper and lower limbs due to strength and flexibility imbalances.

Rehabilitation success depends on imple￾mentation of a safe and progressive therapeu￾tic exercise program. The patient's medical diagnosis, along with the findings from the physical examination, will dictate the starting point for exercise prescription. The patient's baseline status will serve as a means to track improvement with selected interventions.This article highlights exercise prescription to enhance scapular stabilization during the initial phase of rehabilitation, with additional tips for subsequent progression to exercises incorporating the kinetic chain.

Swimmers are notorious for having poor posture; they are characterized as having forward head, rounded shoulders, and increased thoracic kyphosis, which can affect scapular kinematics, muscle strength and range of motion. Improper head position, forward-sloping shoulders, and scapular instabilities are also implicated in arm, shoulder, upper-back, and neck pain.The lateral scapular slide test is proposed as a practical, quantitative method for assessing medio￾lateral inferior angle displacement and recognizingscapular asymmetry in clinical setting. This is a readily usable tool with high reliability.

Dr. W Ben Kibler was the person who first proposed the Lateral scapular slide test to assess the scapular asymmetry, based on the idea that the asymmetry is an abnormality and it needs to be identified and rehabilitated.. Kibler proposed a method characterizing scapular position in 4 different test positions that place the upper extremity in 0 degree (test position 1), 45 degree (test position 2), 90 degree (test position 3) and 135 degree (test position 4) of abduction in the coronal plane.

2. AIM OF THE STUDY

2.1 AIM OF THE STUDY:

The aim of the study is to evaluate the Effectiveness of scapular stabilization exercises for scapular asymmetry among the elite swimmers using lateral scapular slide test.

2.2 OBJECTIVES OF THE STUDY:

To evaluate the effectiveness of Scapular stabilization exercises on Scapular assymmetry

To evaluate the effectiveness of Scapular stabilization exercises on Scapular asymmetry using lateral scapular slide test.

To evaluate the Effectiveness of scapular stabilization exercises for scapular asymmetry among the elite swimmers using lateral scapular slide test.

3.NEED OF THE STUDY:

The need of the Study is to evaluate the effectiveness of scapular stabilization exercises for scapular asymmetry among the elite swimmers using lateral scapular slide test.

3.1 BACKGROUND OF THE STUDY:

Scapular-stabilization prescription should begin with isometric or closed chain exercises.Prescribing closed-chain exercises for the scapula is recommended early inbrehabilitation as the best exercise mode to improve scapular motor patterns.Exercise selection ultimately depends on the athlete's diagnosis and functional level. Range-of-motion restrictions or immobilization after surgery or traumatic injury might initially contraindicate some exercises. Isometric exercises such as scapular retraction allow for early neuromus�cular reeducation of dysfunctional rhomboids and the middle trapezius.

4. HYPOTHESIS:

4.1 NULL HYPOTHESIS:

There is no significant improvement in elite swimmers in scapular stabilization exercises for scapular asymmetry among the elite swimmers using lateral scapular slide test.

4.2 ALTERNATIVE HYPOTHESIS:

There is a significant improvement in elite swimmers in scapular stabilization exercises for scapular asymmetry among the elite swimmers using lateral scapular slide test.

5. REVIEW OF LITERATURE

1.Hariharasudhan Ravichandran, et.al., (2020): To find out the effect of scapular stabilization exercise program in patients with subacromial impingement syndrome, totaling 228 participants were included in this systematic review, as quality assessment of controlled inter-vention studies tool. There was a significant effect on the scapular sta-bilization exercise program on improving pain and disability among sub-jects with subacromial impingement syndrome. This systematic review provides sufficient evidence to suggest that scapular stabilization exer-cises offers effectiveness in reducing pain and disability among sub-jects with subacromial impingement syndrome. However, more trials with larger sample are needed to provide a more definitive evidence on the clinical outcomes of scapular stabilization exercises among pa-tients with impingement.

2. Afsun Nodehi Moghadam, Leila Rahnama, et Al.,. (2020) This study is a wide systematic review including any type of clinical trial in which the effect of any type of therapeutic exercise, including scapular muscle strengthening, stretching, and scapular stabilization exercise, is investigated in adult participants. The other 12 studies used 2-dimensional measurement techniques, of which 8 studies reported significant effects of exercise on scapular position and motion both in SIS patients and in asymptomatic individuals. However, their methodologic quality was debatable. Therefore, there w**as** conflicting evidence for the effect of exercise on scapular dyskinesis.There is a lack of evidence for beneficial effects of exercise in improving scapular position and motion in individuals with scapular dyskinesis. However, exercise is beneficial in reducing pain and disability in individuals with SIS.

3. Afsun Nodehi Moghadam, et Al.,. (2017): The aim of this systematic review protocol is to evaluate the effectiveness of exercise therapy on scapular position and motion in individuals with scapular dyskinesis.Clinical trials reporting the effect of therapeutic exercises (scapular strengthening exercise, scapular stabilization exercise, scapular muscle stretching) with the aims of changing scapular position and motion in individuals with scapular dyskinesis will be included. Two independent reviewers will select studies, extract data, and assess the quality of primary studies. Any disagreement during the selection of studies will be discussed and decided by the whole team.This is the first systematic review protocol aiming to assess the effectiveness of exercise therapy in individuals with scapular dyskinesis.

4. Kevin J McQuade, John Borstad, Anamaria Siriani de Oliveira et Al. The objectives are to critically examine current beliefs about scapular stabilization, to discuss definitions of stabilization and stability in the context of the scapulothoracic region, and to evaluate key evidence regarding scapular stabilization and scapular dyskinesia. Several new approaches that may affect the understanding of normal and atypical scapula motion are explored. Finally, a historical analogy is presented and future research and clinical directions are suggested. The aims are to lead readers to the essential concepts implied on scapular stabilization, to increase the critical thought process in rehabilitation practice, and to suggest some open topics to be explored in future research**.**

5. Shohreh Noorizadeh Dehkordi, Abbas Ali Keshtkar, Zahra Mosallanezhad (2017) et Al.,. The aim of this systematic review protocol is to evaluate the effectiveness of exercise therapy on scapular position and motion in individuals with scapular dyskinesis. Clinical trials reporting the effect of therapeutic exercises (scapular strengthening exercise, scapular stabilization exercise, scapular muscle stretching) with the aims of changing scapular position and motion in individuals with scapular dyskinesis will be included. Two independent reviewers will select studies, extract data, and assess the quality of primary studies. Any disagreement during the selection of studies will be discussed and decided by the whole team.This is the first systematic review protocol aiming to assess the effectiveness of exercise therapy in individuals with scapular dyskinesis. The systematic review doesn’t require ethics approval because all data used will be provided from published documents. The results of this study will be published in a peer-reviewed journal.

6. Kyoung Bin Min, Sang Min Lee, Jae Chul Yoo et Al.,. We aim to systematically review the effect of a scapular stabilization exercise (SSE) on pain and dysfunction in patients with nonspecific chronic neck pain (NP). We searched the PubMed, EMBASE, CINAHL, and Cochrane Library databases using the terms (NP [MeSH] OR NP OR cervical pain OR neck ache OR cervicalgia) AND (scapular exercise OR periscapular exercise OR SSEs). We included suitable studies that met the study’s inclusion criteria. Among the 227 studies identified by our search strategy, a total of four (three randomized controlled studies and one prospective study) met the inclusion criteria. The SSE was intense. It included three sets of 10 repetitions. In most of the studies, the exercises were conducted 3 times per week. Most studies reported that the SSE improved pain and dysfunction in patients with nonspecific chronic NP; however, the reviewed articles did not use the same variables for measurement. Additionally, the sample size was small. Although several studies show that SSE might improve NP and dysfunction, the effects of SSE on pain and dysfunction in the neck region remain unclear because the number of studies was small. Further high-quality studies are necessary to identify the detailed effects of SSE in patients with NP.

7. Reijneveld, Suzie Noten, Lori A Michener, Ann Cools et al., (2017) To systematically review the literature on the clinical outcomes of scapular-focused treatments in participants with subacromial pain syndrome (SPS).Four studies were included describing various scapular-focused interventions, including scapular-focused exercise therapy, scapular mobilisation and scapular taping. All included studies had a PEDro score of 6 or higher, indicating low risk of bias. There was moderate evidence that scapular-focused treatment compared with other physiotherapeutic treatment is effective in improving scapular muscle strength in participants with SPS. Conflicting evidence was found for improvements in pain, function and clinical measures of scapular positioning. No evidence was found for improvements in shoulder range of motion or rotator cuff muscle strength.There is some support for the use of scapular-focused exercise therapy in patients with SPS. Owing to the low number of studies, no firm conclusions can be drawn. Therefore, more randomised controlled trials are needed to determine the clinical outcomes of scapular-focused exercise therapy, scapular mobilisation techniques and scapular taping in patients with SPS.

8. Hyun Choi, Young-Jun Moon, Joon-Su Park et Al.,. The purpose of this study was to investigate the effects of scapula movement on neck alignment and the muscles in patients with forward head posture, who has the structural changes around the neck caused from the forward head posture, when scapular stabilization exercise is applied.A sample of 30 patients with forward head posture were recruited and participated in an intervention for 30 minutes a day, three times per week for 4 weeks. Fifteen patients were assigned to the scapular stabilization exercise group and the remaining 15 were assigned to the neck stabilization exercise group. Before the intervention, the craniovertebral angle (CVA), cranial rotation angle (CRA), and muscle activity of the muscles around the neck were measured. Four weeks later, these 3 factors were re-measured and analyzed.Scapular stabilization brought about improvement in posture through activation of the neck muscles, the lower trapezius, and the serratus anterior. Therefore, the intervention has a positive effect on neck alignment by reducing the compensatory movements of the muscles involved in forward head posture. Structural changes are observed.

9. GulBaltaciPT, Ph D et Al.,. To investigate the effects of 2 different exercise programs on 3-dimensional scapular kinematics, disability, and pain in participants with subacromial impingement syndrome (SIS).The participants were randomized in 2 different exercise groups: (1) shoulder girdle stretching and strengthening with additional scapular stabilization exercises based on a kinetic chain approach (intervention group), and (2) shoulder girdle stretching and strengthening exercises only (control group).Progressive exercise training independent from specific scapular stabilization exercises provides decreased disability and pain severity in impingement syndrome

6. MATERIALS AND METHODOLOGY

Source of data

Gandhi sports complex, Swimming Society, Pondicherry.

SAMPLE SELECTION

6.1 Sample Population: Competitive swimmers

6.2 Sample Design: Simple Random Sampling

6.3 Sample Size: 50 swimmers

6.4 Design: Experimental Study

6.5 Duration of the study: Two months i.e. 8 weeks

7. MATERIALS USED

- Measuring tape
- Goniometer
- Marker pen
- Clip board

8. SELECTION CRITERIA

8.1 INCLUSION CRITERIA

1. Swimmers within the age limit between 12-25 years.
2. All swimmers are members of the same swimming club.
3. Training sessions of minimum 6 times per week and 12 hours weekly.

8.2 EXCLUSION CRITERIA

1. Previous shoulder surgery, or shoulder pain that interfered with swimming training.
2. Presence of shoulder instability due to previous injury in the past six months.
3. A subject with history of clavicular pathology.
4. A history of cervical or thoracic pathology.

9. OUTCOME MEASURE:

The lateral scapular slide test

The subject was in standing position and the back of the subject was adequately exposed. First the distance from inferior angle of scapula to the spinous process of T7 was measured. With a marker, the inferior angle of scapula and spinous process of T7 were marked. Kibler stated that in each position the distance measured should not vary more than 1 cm to 1.5 cm (0.5 inch to 0.75 inch) form the original measure.. The distance from the inferior angle of scapula to T7 spinous process wasmeasured in centimetre using a measuring tape.

The examiner was standing behind the subject and asked the subject to keep his/her hands at various positions were measured:

In the first position, the subject's hands were at the side of the body with 0 degree of shoulder abduction. In the second position, the subject's hands were at the waist of the body with 45 degree of shoulder abduction. In the third position, the subject's hands were perpendicular to the body with 90 degree of test position. In the fourth position, the subject's hands were raised to 135 degree shoulder abduction. When the test was done, the movement pattern of the scapula as well as scapular dyskinesia was also being noticed.

10. PROCEDURE

50 elite competitive swimmers fulfilling the inclusion criteria were selected for the study. They were then randomly selected for the test procedure. All subjects were explained about the purpose of the study and were educated about the test procedure that is to be conducted. Before participating in the study, the subject was asked to sign informed consent documents..

10.1 Standing forward flexion('full-can') exercise

Stand facing a mirror with the hands rotated so that the thumbs face forward. While keeping the shoulder blade 'set' and keeping the elbows straight, raise the arms forwardand upward to shoulder level with a slight outward angle (30°). Pause for one second and slowly lower and repeat. Perform 2 sets of 12 repetitions.

10.2 Wall climbing exercise

Slowly climb up the wall with hands, and then slowly return down to the original position.

Intensity: It depends on the subjective feeling of the patient—the patient feels slightly tired and slightly shortness of breath (RPE range 11 to 15). Each exercise starts with 10 reps*3 sets, and increases 5 reps a week.

Frequency: once a day, for 8 weeks.
Time: The overall exercise time is 20–30 min.

10.3 Pendulum exercise

The healthy arm is placed on the table to support the body, while the affected arm slowly swings back and forth, side to side, and in circles.

10.4 External rotation exercise

Standing or sitting, hold a stick in hands and bend elbows, then push and pull the stick to both sides with the healthy hand, so as to do internal rotate and external rotate.

11. DATA ANALYSIS AND RESULTS

All analysis was carried out in SPSS Windows Version 16.0. An alpha level of 0.05 was used to determine statistical significance. Microsoft word and excel has been used to generate tables and pie diagram. Statistical analysis was performed using z-test to evaluate the significance of correction of scapular asymmetryamong swimmers using lateral scapular slide test. The test was carried out in four different positions of shoulder abduction.

Table1: The percentage of symmetry and asymmetry in the respondents at 0 degree scapular position before and after intervention:

	Frequency	Percentage
Asymmetry	24	42
Symmetry	26	58
Total	50	100

For 0 degree, z= -.98928, p value= 0.00139. The result is significant at $p<0.05$. It has been inferred that there is significant symmetry of scapula after intervention.

Table 2: The percentage of symmetry and asymmetry in the respondents at 45 degree scapular position before and after intervention:

	Frequency	Percentage
Asymmetry	32	64
Symmetry	18	36
Total	50	100

For 45 degree, z= 0.11918, p value= 0.45224. The result is significant at $p<0.05$. It has been inferred that there is significant symmetry of scapula after intervention.

Table 3: The percentage of symmetry and asymmetry in the respondents at 90 degree scapular position before and after intervention:

	Frequency	Percentage
Asymmetry	37	74
Symmetry	13	26
Total	50	100

For 90 degree, z=1.10704, p value=0.1335. The result is significant at $p<0.05$. It has been inferred that there is significant symmetry of scapula after intervention.

Table 4: The percentage of symmetry and asymmetry in the respondents at 135 degree scapular position after intervention:

	Frequency	Percentage
Asymmetry	34	68
Symmetry	16	32
Total	50	100

For 135 degree, z=1.22726, p value= 0.10935. The result is significant at $p<0.05$. It has been inferred that there is significant symmetry of scapula after intervention.

12. DISCUSSION

The purpose of the study was to evaluate the effectiveness of scapular stabilization exercises for correction of scapular asymmetry among swimmers using lateral scapular slide test. An experimental study with 50 subjects fulfilling the inclusion criteria were allowed to participate in the study.The study results shows that there is significant scapular symmetry in 45,90 and 135 degree of shoulder abduction respectively in among swimmers.

With the change of people's life style and work style, the incidence of periarthritis of the shoulder is increasing year by year. Early studies have revealed that patients with periarthritis of the shoulder usually have Scapular Dyskinesis, and there is a close relationship between SD and scapular muscle imbalance. Current evidence suggests that scapular control is an important component of scapular rehabilitation and scapular stabilization exercise is effective in reducing pain and improving function]. Scapular stabilization exercise that includes stretch�ing and strengthening emphasis scapular position and kinematics, allowing the scapula to perform the role of energy transfer, serving as the basis for muscle activation and as a link in the kinetic chain. However, there is a lack of targeted scapular stabilization exercise based on the type of SD.

The freestyle stroke, which places the humerus predominantly internal rotation as it helps to propel the body in the water, is practised extensively during training. During motion of the humerus in the shoulder, the location of the scapula can change or remain stable due to the motion of muscles adjacent to the scapula. The repetitive nature of strokes during swim practice has contributed to the changes we observed in scapular position during upper extremity elevation. As stability at the scapulothoracic joint depends specially on the surrounding musculature to resist fatigue, proper scapular kinematics requires adequate scapular muscle function. Fatigue of the scapular muscles may be a mechanismcontributing to the shoulder pathologies.

The LSST used in this study is found to be reliable in finding out the asymmetry of scapula in elite swimmers. Therefore the alternate hypothesis is accepted for the test position at 45, 90 and 135 degree respectively which states that there is significant symmetry among swimmers after scapular stabilization exercises using lateral scapular slide test.

13. CONCLUSION

Based on the statistical analysis, it is concluded that there is significant symmetry of scapula found with the LSST test position at 45 degree, 90 degree and 135 degree, mostly it drecreases with the elevation of the shoulder joint.

"There is Effectiveness of scapular stabilization exercises on scapular asymmetry among swimmers using lateral scapular slide test".

14. REFERENCES

1. DubeAdiele, Gundani Patrick Morgan. Prevalence of Musculoskeletal Injuries in Mles and Females Practising Swimming from Higher School of Zimbabwe. American Journal of Sports Science. 2018; 6(1):8-11.

2. Elsbeth van Dorssen, Rod Whiteley, Andrea Mosler. Shoulder Injuries in Swimming Meeting the challenge. Aspetar Sports Medicine Journal,2010;3(3):571-580.

3. Jacopo PreziosiStadoli, PT, Francesco Fratalocchi, PT, Vittorio Candela, MD, et al. Scapular Dyskinesis in young, Asymptomatic Elite swimmers. The orthopaedic Journals of Sports Medicine 2018; 6(1), 2325967117750814,DOI:10.1177/2325967117750814.

4. Kibler WB, McMullen J, Uhl T. Shoulder rehabilitation strategies, guidelines, and practice. Orthop Clin North Am. 2001;32(3):527-538.

5. McMullen J, Uhl TL. A kinetic chain approach for shoulder rehabilita tion. J Athl Train. 2000;35(3):329-337.

6. Wilk KE, Meister K, Andrews JR. Current concepts in the rehabilitation of the overhead throwing athlete. Am J Sports Med. 2002;30(1):136-151.

7. Kiber WB. Rehabilitation of rotator cuff tendinopathy. Clin Sports Med. 2003;22(4):837-847.

8. Lear LJ, Gross MT. An electromyographical analysis of the scapular stabilizing synergists during a push-up progression. J Orthop Sports Phys Ther. 1998;28(3):146-157.

9. Moseley JB, Jobe FW, Pink M, Perry J, Tibone J. EMG analysis of the scapular muscles during a shoulder rehabilitation program. Am J Sports Med. 1992;20(2):128-134.

10. Townsend H, Jobe FW, Pink M, Perry J. Electromyographic analysis of the glenohumeral muscles during a baseball rehabilitation program. Am J Sports Med. 1991;19(3):264-272.

11. Decker MJ, Hintermeister RA, Faber KJ, Hawkins RJ. Serratus anterior muscle activity during selected rehabilitation exercises. Am J Sports Med. 1999;27(6):784-791.

12. Ekstrom RA, Donatelli RA, Soderberg GL. Surface electromyographic analysis of exercises for the trapezius and serratus anterior muscles. J Orthop Sports Phys Ther. 2003;33:247-258.

13. Fleck SJ, Kraemer WJ. Designing Resistance Training Programs. Cham paign, Ill: Human Kinetics; 1987

13. W. Benjamin Kibler,AaronSciascia, Trevor Wilkes. Scapular Dyskinesis and Its Relation to Shoulder Injury.J Am AcadOrthopSurg2012;20:364-372

14. Pernille H Madsen, Klaus Bak, Ulrik Welter et al. Training Induces Scapular Dyskinesis in Pain Free competitive swimmers: A Reliability and Observational Study. Clinical journal of sport medicine 2011; 21(2):109-11.

15. James N. Johnson, MD, Jason Gauvin, PT, ATC, Michael Fredericson, MD. Swimming Biomechanics and Injury Prevention. THE PHYSICIAN AND SPORTS MEDICINE-VOL 31 -NO.1-JANUARY 2003.

16. Ross Sanders, Alison Alcock, Neil Donald et al. Case studies of asymmetries in swimming. 2013.

17. Corrie J Odom, Andrea B Taylor, Christine E Hurd et al. Measurement of scapular asymmetry and assessment of shoulder dysfunction using the lateral scapular slide test: a reliability and validity study. Physical Therapy 2001; 81(2):799–809

18. Devid J Magee, PhD, BPT; Orthopedic Physical Assessment; 6th edition; Published by RELX India Private Limited, Resisted office: 818, 8th floor, Indraprakash Building, 21, Barakhamba Road, New Delhi-110001; ISBN:978-1- 4557-0977-9.

19. VAP Coombs. Scapula stability of symptomatic and asymptomatic competitive female swimmers. November 2001 Vol 87, Issue 11, page 603

20. LeandaMckenna, Joanne Cunningham, Leon Straker. Inter-tester reliability of scapular position in junior elite swimmers. Physical Therapy in Sport 2004, vol. 5,issue 3, pages 146-155.

21. Y.Blache , B.Gillet, J.Selin, V.SevrezI. Scapular kinematics during scaption in competitive swimmers. European Journal Sport Science, 2018, 18(5), pp.659-666.

22. Fernanda A.P. Habechian et al. Swimming practice and scapular kinematics, scapulothoracic muscle activity, and Pressure Pain Threshold in young swimming. Journal of Athletic Training 2018; 53(11): 1056-1062.

23. Dr. Jyotidahaliya. Effects of scapular position on neck pain in swimmers.International Journal of Health Sciences & Research Vol.7; Issue: 11; Nov 2017 ISSN: 2249-9571

24. MaayanBussibaMaor, Tatyana Ronin, Leonid Kalichman. Scapular Dyskinesis among competitive swimmers, Journal of Bodywork & Movement Therapies 2016.

25. McClure P, Greenberg E, Kareha S. Evaluation and management of scapular dysfunction. Sports Med Arthrosc Rev. 2012;20(1):39–48. https://doi.org/10. 097/JSA.0b013e31824716a8.

26. De Mey K, Danneels L, Cagnie B, Van den Bosch L, Flier J, Cools A. Kinetic chain influences on upper and lower trapezius muscle activation during eight variations of a scapular retraction exercise in overhead athletes. J Sci Med Sport. 2013;16(1):65–70. https://doi.org/10.1016/j.jsams.2012.04.008.

27. Castelein B, Cagnie B, Parlevliet T, Cools A. Serratus anterior or pectoralis minor: which muscle has the upper hand during protraction exercises? Man Ther. 2016;22:158–64. https://doi.org/10.1016/j.math.2015.12.002.

28. Camargo P, Neumann D. Kinesiologic considerations for targeting activation of scapulothoracic muscles - part 2: trapezius. Braz J Phys Ther. 2019;23(6): 467–75. https://doi.org/10.1016/j.bjpt.2019.01.011.

29. Kibler W, Sciascia A. Evaluation and management of scapular dyskinesis in overhead athletes. Curr Rev Musculoskelet Med. 2019;12(4):515–26. https://doi.org/10.1007/s12178-019-09591-1.

30. Neumann D, Camargo P. Kinesiologic considerations for targeting activation of scapulothoracic muscles - part 1: serratus anterior. Braz J Phys Ther. 2019; 23(6):459–66. https://doi.org/10.1016/j.bjpt.2019.01.008.