Acta Scientific Orthopaedics (ISSN: 2581-8635)

Volume 8 Issue 3 March 2025

Research Article

"A Cross-sectional Study to Determine the Relationship Between Scapular Position, Humeral Head Position and Shoulder Injury Among Elite Junior Swimmers"

Divya Lawrance*

BPT, MPT-Musculoskeletal Disorders and Sports Physiotherapy, MIAP, India

***Corresponding Author:** Divya Lawrance, BPT, MPT-Musculoskeletal Disorders and Sports Physiotherapy, MIAP, India.

DOI: 10.31080/ASOR.2025.08.1024

Received: December 16, 2024

Published: February 28, 2025

Abstract

Background and Objectives: Swimming is one among the popular sports played in the world and is unique in nature. Shoulder pain is a significant problem in swimmers and has potential to be a greater problem in adolescent swimmers. The proximity of the humeral head to the acromion is the major factor in subacromial space narrowing with associated pain and loss of function. Any faulty movements during swimming will result in altered biomechanics of the shoulder girdle, where the scapular stabilizing muscles undergo fatigue and become weak potentially causing the abnormal positioning and abnormal scapular glides. Therefore, it is very important to be able to reliably and quantitatively assess the habitual humeral head position in relation to the acromion. There are well developed techniques to measure this includes Fluoroscopy and MRI. But these methods are not practical for everyday clinical use. There are established manual methods such as Kibler scapular measurement techniques to evaluate this. The aim and objectives of this study is to examine the changes in scapular position among the junior elite swimmers by using Kibler Method 2nd and Kibler Method 3rd of scapular measurement and to examine the changes in humeral head position in swimmers by using the Humeral Head Assessment Technique and also to determine the correlation between scapular position, humeral head position and shoulder injury among the junior professional swimmers.

Methodology: Subjects included adolescent professional swimmers (N = 30) with mean age of 14.10 ± 2.79. The outcome measures included are Kibler Method 2nd and Kibler Method 3rd to measure the scapular position and Humeral Head Assessment Technique in two different positions to measure the anterior translation of humerus in relation to the acromion.

Result: The scapular measurement by using Kibler 3rd method showed moderate correlation (r = 0.072) with shoulder pain. Significant correlation found between Humeral Head Position and shoulder pain in hands on hips position (r = 0.048).

Conclusion: Scapular position by using Kibler 3rd method is of a good clinical measure in everyday clinical practice. Kibler 3rd method and humeral head in the hands-on hips position measure appears to be a clinically useful tool in assessment of the shoulder pain in young athletes.

Keywords: Kibler 2nd Method; Kibler 3rd Method; Shoulder Pain; Reliability; Humeral Head Anterior Translation

Introduction

Swimming is a recreational sport taken up by various age groups with the primary aim to maintain a good degree of physical fitness. Swimming is one among the popular sports played in the world and is unique in nature [1].

Swimming is a popular sport with children beginning their competitive career early at the age of 5 or 6 years old [2]. Training sessions are done by professional swimmers are up to 12 times per week with an average of 8 km swum per day. Approximately 80% of the trainers are using the free style technique [3]. Competitive swimming is a demanding and time-consuming sport, with athletes at the elite level practice. During the first year of practice, the average top-level swimmer may perform over 5,00,000 strokes per arm [4]. Competitive swimming has a distinct profile of injuries ranging from shoulder joint pain to back pain occurring mainly due to repeated microtrauma as a result of increased hours of training associated with the sport [5].

The proximity of the humeral head to the acromion is a proposed factor in subacromial space narrowing. It may subsequently cause rotator cuff degeneration and impingement syndromes with associated pain and loss of function. Determining the habitual humeral head position may provide a useful component of preseason screening for swimmers [6].

Swimmer's shoulder

Swimmer's Shoulder is a musculoskeletal condition that results in symptoms at the anterior lateral aspect of the shoulder, sometimes around the subacromial region. The particular repetitive arm movement over the course of many years, is believed to be the main etiologic factor in the overuse syndrome known as "Swimmer's Shoulder" [7]. The symptoms may be associated with impaired posture, Glenohumeral joint (GH) mobility, neuromuscular control or muscle performance. Training errors such as overuse or misuse may also contribute to this condition [8]. Kennedy used the term swimmer's shoulder in the 1970s to describe anterior shoulder pain in swimmers during and after workouts. Contributing factors for swimmer's shoulder are thought to include (i) Overuse and subsequent fatigue of the muscles around the shoulder, scapula and upper back. (ii) GH laxity. (iii) The mechanics of the swimming stroke [15]. Swimmer's shoulder is a condition with a gradual onset due to repetitive activity and can be classified as microtrauma. The etiology of microtrauma is multifactorial [16].

Prevalence and incidence of shoulder pain

The incidence of shoulder pain ranges from 40-70% in competitive swimmers. Shoulder pain is reported in all four strokes in both distance swimmers and sprinters. More than 90% of the propulsive power in swimming comes from the upper extremity [7].

Biomechanics of swimming

The movements in swimming are closed chain mechanics, meaning that the distal segment (i.e., the hand) is the relatively fixed segment whereas the body is moved over the top of the hand [8]. A large part of the biomechanical analysis of competitive swimming is dedicated to the four competitive swimming strokes 1) The front crawl or free style, 2) The back stroke, 3) The breast stroke, 4) The butterfly stroke [10].

Patho-mechanics of painful shoulder

In swimmers an insufficient scapular protraction and lateral rotation would lead to muscular imbalances causing an alteration in the neuromuscular control and predisposing the swimmer to injury [11]. Swimmers also strive to have a long stroke as this improves the propulsion but the resultant prolonged shoulder adduction and internal rotation leads to hypo-vascularity of supraspinatus tendon and increases the risk of tendinopathy [12].

Normal scapular function is a pre requisite for the normal movement of the upper extremity and any biomechanical faults related to scapula or humeral head can lead to shoulder injury among the elite swimmers during their training session. Therefore, the need of the study is to determine the relationship between scapular position, humeral head position and shoulder injury among professional swimmers.

Study design

A Cross-sectional study (As in this study we have observed for the scapular position and humeral head position)

Source of data

A sample of 30 competitive swimmers who were regularly practicing and often participating in state level competitions for minimum past 2 years were recruited for the study. Swimmers were included in the study if they performed 3-10 training sessions per week (mean = 7). The subjects were taken from Mangala Indoor Swimming stadium, Mangalore.

Sample

Volunteers and legal guardians read and signed an informed consent form prior to entering the study. After the selection of

subjects fulfilling the inclusion and exclusion criteria, physical examination was done to assess for the evidence of scoliosis, congenital defect of scapula, scapular winging and neuro-muscular disorder affecting the shoulder function. Pre participation data was collected which included age, hand dominance, hand span(distance measured from the tip of the thumb to the tip of the little finger), arm span(distance measured between tip of middle finger of one hand to another hand when raised parallel to the ground at shoulder height), weight, height, BMI, number of years in competitive swimming (sports age), average time in swimming training/day, best swimming experience, number of competitions participated, competitive swimming results, training programmed/ group, stroke used frequently, medical or supplements information, weekly training morning and evening schedules and injury profile. All subjects completed a questionnaire covering activity levels and history of shoulder pain.

Inclusion criteria

- Swimmers aged between 12-19 years were included
- Swimmers who had Experience of professional swimming for at least 2 years.
- 3.Swimmers included in the study if they performed 3-10 training sessions per week.

Exclusion criteria

- History of surgery around shoulder, neck and rib cage.
- History of trauma around the shoulder joint.
- History of shoulder pain in past 12 months.

Methodology

Kibler 2nd (SMK2) position of scapular measurement, Kibler 3rd (SMK3) position of scapular measurement and Humeral head position assessment.

Scapular measurement methods

The intratester reliability of the Kibler methods ranged from good to high [13]. Prior to taking the scapular measurements the subjects were informed to perform an exercise routine, which included nodding the head forward and backward for five times, doing 10 steps of spot marching, inhaling and exhaling a deep breath and stand in relaxed position facing straight forward. A side to side difference greater than or equal to 1.5 cm was taken clinically significant [14].

Kibler 2nd method of scapular measurement

Position of participant: Subject standing by placing their hands-on hips (45 degree of abduction). The inferior angle of the scapula and the spinous process which is adjacent to the inferior angle was palpated and marked. Linear distance from the Inferior angle of the scapula and adjacent spinous process was measured by an inch tape [14].

Figure a

Kibler 3nd method of scapular measurement

Position of participant: Subjects standing by placing their shoulder/arm at 90-degree abduction and internal rotation by placing thumb down in the scapular plane. The measurement was taken from the inferior angle of scapula to the adjacent spinous process with inch tape [14].

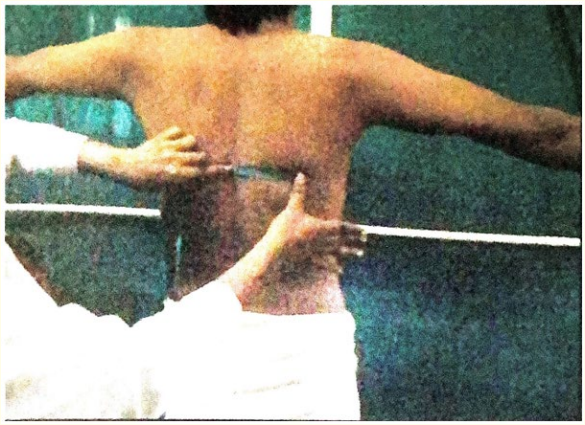

Figure b

Humeral head assessment technique (HHAT)

Humeral head in the hands-on hips position measure appears to be a clinically useful tool in assessment of the shoulder in young athletes. The technique has the ability to reveal reasonably small true differences, particularly the hands-on hips position.[6]In this study the humeral head position assessment was taken in two standing positions; 1) Shoulder in neutral, with thumbs anterior (Humeral Head Assessment Hands Neutral - HHAHN) 2) Hands on hips position with thumbs posterior (Humeral Head Assessment Hands On Hips - HHAHH). Subjects remained standing under the camera between the positions. Measures were repeated on the other side. And the data processed by using the software KLONK Image Measurement. KLONK measures length, area, angle and circumference on images (https://imagemeasurement.com). All measures on all subjects were taken prior to any swimming training sessions.

HHATHN

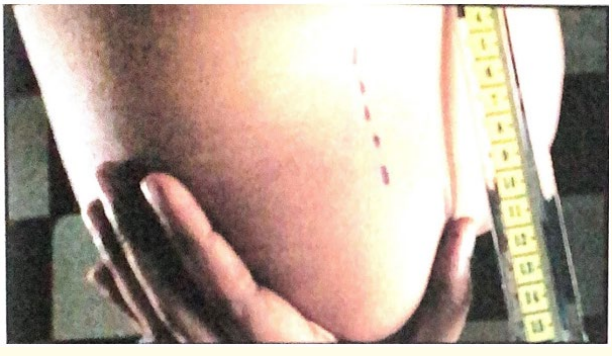

Figure c

HHATHP

Figure d

Humeral head position in relation to the acromion was determined as a horizontal distance between the anterior humeral head and the anterior acromion using palpation. The anterior acromial border was palpated and marked in ink with a marker pen on the subject's skin. The examiner palpated and marked the posterior acromion to allow examiner orientation of surface anatomy (this line was not used in subsequent determination of humeral head position). The most anterior aspect of the subject's humeral head was palpated and the examiner placed finger on this point. A photograph of the palpated shoulder was taken using a digital camera (Sony Cyber-shot DSC-W710 point and amp; shoot) from the superior aspect. A ruler marked with 1 cm divisions was included in the photographic field to allow for scaling correction [8]. The difference in humeral head position between a normal and pathological shoulder of 5mm is considered to be clinically significant [6].

Tools used for data collection

Equipment used are Indelible ink marker, 12-inch length of 1 cm wide inelastic white fabric, 18-inch ruler, Digital camera, KLONK Image Measurement Software 13.1.4.4, Stopwatch, Inch tape, Pen, Paper and table.

Statistical analysis

Descriptive statistics was used to find the mean and standard deviation for baseline characteristics. The percentage of Injury Profile (IP) was calculated for all the variables including SMK2, SMK3, HHAHN and HHAHH. Pearson and spearman were done to find the correlation between all the variables and IP. All data were analyzed using SPSS software.

Results

The results of the study revealed that there was good correlation (r = 0.727) between SMK3 and IP. A moderate correlation (r = 0.409) was found between SMK2 and IP. And study found no correlation between HHAHN and IP and HHAHH and IP.

Correlation table 1

Shows that, there is fair correlation between variables SMK2 and IP. Moderate to good correlation between SMK3 and IP. Very poor correlation between HHAHN and IP. And there is fair correlation found between HHAHH and IP.

	SMK2	SMK3	HHAHN	HHAHH	IP
SMK2	-----	0.418	0.151	0.289	0.409
SMK3	0.418	-----	0.013	0.189	0.727
HHAHN	0.151	0.013	-----	0.089	-0.058
HHAHH	0.289	0.189	0.089	----	0.048
IP	0.409	0.727	-0.058	0.048	-----

Table 1

Discussion

Shoulder pain in elite level swimming could cause significant interference with their training and this may result in decreased performance in their career. The scapular kinematic abnormalities associated with GH joint stability is greatly influencing the shoulder mechanics of shoulder. McMaster stated that elite level swimmers can produce up to one million strokes per year. Given this information, most likely the swimmers will experience any kind of shoulder discomfort in their career compared to the recreational swimmers. In a survey of 532 collegiate and 395 master swimmers, half of the swimmers had a history of 3 or more weeks of shoulder pain that forced them to alter their training [15,17]. Paul et al says that GH laxity that is greater than normal can lead to shoulder pain and dysfunction in elite swimmers. Failure of the rotator cuff and the scapular stabilizers to maintain the humeral head in the glenoid fossa can lead to excessive humeral head migration and compression of the tendons of the humeral head on the undersurface of the acromion [19]. The causes of shoulder pain in swimmers was thought to anatomical previously, but now it is found that this is due to the biomechanical fault in the scapular and humeral head position. Anterior and superior habitual positioning is a contributing factor and any changes in scapular position and anterior translation of humeral head can be the most common causes for shoulder pain in adolescent swimmers. Adolescents may be at particular risk of shoulder pain compared to adults due to the combination of the changes that could occur in adolescence and the training load associated with swimming [15,20-22]. This study will give an overall insight about the normal as well as abnormal shoulder biomechanics and the relative difference in scapular position, humeral head position and its association with the shoulder pain in adolescent swimmers, which can be helpful in training and rehabilitating them to improve their performance. Swimmers selected in this study were with the age group ranging from 12 to 19 years, with the mean age 14.10 years. The mean height, weight and BMI were as 151.63cm, 44.10 kg and 18.50 Kg/m^2 respectively.

Determining the scapular and habitual humeral head position may provide a useful component of preseason screening for athletes participating in swimming. Therefore, the need is to identify the risk factors and to measure the association of shoulder pain with change in the scapular position and habitual humeral head position is of a great importance in swimmers for their better performance and career. Furthermore, a small research has been done to identify the relationship with shoulder pain and biomechanical changes in scapula and humeral head. There are some studies done on scapular position and humeral head position among swimmers, but very few studies are there based on the clinical assessment tool which can be easily practiced in clinical set up for the everyday clinical use. But there are no such studies evident in India. So, here we have intended to find the relationship between scapular position, humeral head position and shoulder injury among the competitive swimmers. Our study shows an injury profile of 71.4% among swimmers, during the past 12 months with SMK3 measurement including both male and female subjects. The results showed that, there was moderate to good correlation between the variables SMK3 and IP (r = 0.72). Variables SMK2 and IP (r = 0.40) showed fair correlation in this study. Therefore, SMK3 measurement technique may be more reliable and sensitive to predict the shoulder pain among swimmers. HHAHH and IP (r = 0.48) are having fair correlation when compared to HHAHN. Humeral head position assessment using the hands-on hips position may be more useful and the clinician can preferentially use this position for humeral head assessment technique.

Conclusion

This study concludes that there is a significant association between SMK3 and shoulder pain among competitive swimmers. Humeral head assessment technique has the ability to find the association with shoulder pain especially the hands-on hips position. Therefore, Kibler 3rd method and humeral head in the hands-on hips position measure appears to be a clinically useful tool in the clinical assessment of shoulder pain in young athletes.

Bibliography

1. AR Richardson. "Biomechanics of swimming: The shoulder and knee". *Clinics in Sports Medicine* (2005).
2. JO'Donnell., *et al*. "Identifying and Managing Shoulder Pain in Competitive Swimmers". How to Minimize Training Flaws and Other Risks". *The Physician and Sports Medicine* 33.9 (2015).
3. Krüger K., *et al*. "Subacromial Impingement in Competitive Swimmers". *European School of Physiotherapy* (2010).
4. Ka Pik Eva Su., *et al*. "Scapular Rotation in Swimmers with and without Impingement Syndrome: Practice Effects". *Medicine and Science in Sports and Exercise* 36.7 (2000): 1117-1123.
5. Pedro Figueiredo., *et al*. "Interplay of biomechanical, energetic, coordinative, and muscular factors in a 200 m front crawl swim". *Biomed Research International* (2013).
6. McKenna LJ., *et al*. "The validity and intra-tester reliability of a clinical measure of humeral position". *Manual Therapy* 06 (2008): 443.
7. Sumant G. Krishnan and Richard J Hawkins. "The Shoulder and the Overhead Athlete: A Holistic Approach Hardcover" (2004).
8. Brian J Tovin. "Prevention and Treatment of Swimmer's Shoulder". *North American Journal of Sports Physical Therapy* 1.4 (2006): 166-175.
9. Scott A Heinlein and Andrew J Cosgarea. "Biomechanical Considerations in the Competitive Swimmer's Shoulder". *Sports Health* 2.6 (2010): 519-525.
10. Tiago M Barbosa., *et al*. "Submitted Biomechanics of Competitive Swimming Strokes" (2011).
11. T Puckree and KJ Thomas. "Shoulder injuries in competitive swimmers in kwazalunatal". *SAJSM* 18.1 (2006).
12. Sneh Bansal., *et al*. "Shoulder impingement syndrome among competitive swimmers in India - prevalence, evaluation and risk factors". *Journal of Exercise Science and Fitness* 5.2 (2007).
13. Mark H Gibson., *et al*. "A reliability study of measurement techniques to determine static scapular position". *Journal of Orthopaedics and Sports Physical Therapy* (1995).
14. W Ben Kibler. "The role of scapula in athletic shoulder function". *American Journal of Sports Medicine* 26 (1998): 325.
15. Marilyn Pink., *et al*. "The normal shoulder during freestyle swimming: An electromyographic and cinematographic analysis of twelve Muscles". *The American Journal of Sports Medicine* 19 (1991): 569-576.
16. Sumanth G., *et al*. "The shoulder and the overhead athlete: A holistic approach hardcover" (2004).
17. Rupp S., *et al*. "Shoulder problems in high level swimmer's impingement anterior instability muscular imbalance?" *Sports Medicine* 16.8 (1998): 557-562.
18. Paul A Borsa., *et al*. "Scapular positioning patterns during humeral elevation in unimpaired shoulders". *Journal of Athletic Training* 38.1 (2003): 12-17.
19. Tovin BJ. "Prevention and treatment of swimmer's shoulder". *North American Journal of Sports Physical Therapy* 1.4 (2006): 166-175.
20. Warner JJP., *et al*. "Scapulothoracic motion in normal shoulders and shoulders with glenohumeral instability and impingement syndrome". *Clinical Orthopaedics* (1992).
21. Psycharakis SG. "A longitudinal analysis on the validity and reliability of ratings perceived exertion for elite swimmers". *Journal of Strength and Conditioning Research* (2010).
22. Weldon EJ and Richardson AB. "Upper extremity overuse injuries in swimming: A discussion on swimmers' shoulder". *Clinical Journal of Sports Medicine* 20.3 (2001): 423-438.