ISSN Print: 2394-7500
ISSN Online: 2394-5869
Impact Factor: 8.4
IJAR 2022; 8(9): 164-167
www.allresearchjournal.com
Received: 18-06-2022
Accepted: 22-07-2022

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Pilot study of inter and intra rater reliability of scapular scaption angle measurement

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Abstract
Introduction: The shoulder joint is a complex joint. It consists of a web of soft tissue structures which connect the joints and permit mobility within its limits. The biomechanics of shoulder joint is complicated since the shoulder joint complex consists of 4 joints. The GH joint is one of the most mobile joints in the body which has 6 degrees of freedom and hence it is very important to stabilize it. Scaption is a functional movement pattern involved in shoulder biomechanics and is an excellent exercise for muscle strengthening.
Purpose of the study: To measure the scaption angle of the scapula at three different levels.
Case description: The subject is asked to sit on a high stool with hips and knees flexed and after palpation at the superior, mid and inferior level by flexing the patient's arm at 30 degrees and the thumbs positioned upward; the planes of the scapula and humerus are aligned and are measured.
Method: The study population includes normal subjects of all ages who will be participating in this study for the duration of 3 months. Arbatary sampling was done with a sample size of 30 subjects. (May increase or decrease depending upon intra class correlation values).
Conclusion: This study concludes that the digital protractor is a device that has reliability values ranging from moderate to very good.

Keywords: Shoulder, scaption, digital protractor

Introduction
The shoulder is a complicated joint that connects the upper extremities to the trunk or axial skeleton. It is essential for the operation of the arms and hands, the dexterity of which distinguishes humans from many other animals. The shoulder is primarily composed of a web of soft tissues that cover the bones. The scapula is a flat, triangular bone that forms the posterior side of the shoulder girdle and has 17 muscle attachments, as well as an anterior projection called the glenoid that forms half of the main shoulder joint [1].
The shoulder joint complex is made up of four anatomical joints and one virtual one (subacromial), which allows for exceptional mobility [2].
The biomechanics of the shoulder are quite complicated. First, it is made up of four joints (glenohumeral, acromioclavicular, scapulothoracic, and sternoclavicular). The glenohumeral joint is the most movable joint in the human body, with six degrees of freedom, allowing the hand to acquire a broad range of postures. 18 muscles work together to provide motion. The shoulder requires all of the anatomic parts to operate together in order to function appropriately [3].
The humerus is the upper arm's long bone, with a proximal head that articulates within the shoulder joint. The shoulder complex is made up of four minor joints: the glenohumeral (GH) joint, as well as the acromioclavicular (AC), sternoclavicular (SC), and scapulothoracic (ST). As the ball, or humeral head, engages with the socket, or glenoid, the GH joint is a "ball-and-socket" joint. The hyaline cartilage covers both surfaces. Only around 25% of the humeral head surface area effectively contacts the glenoid surface. The teres major muscle, which originates along the lateral inferior scapula and inserts on the medial part of the humeral shaft, is another scapulohumeral muscle. It aids in the internal rotation and adduction of the humerus. Innervation occurs through the lower and middle subscapular nerves [1].

Because the shoulder joint is the least congruent in the human body, it has an enormous potential range of motion with daily activities. These motions include a complicated interaction between the osseous components (scapula, humeral head, and clavicle) and the adjacent soft tissue, which includes the shoulder capsule, ligamentous, labral, and muscular stabilizers [4].

The capsulolabral components and the bony architecture of the glenoid offer static stability to the glenohumeral joint. The principal static stabilisers are the glenohumeral ligaments, which are a thickening of the joint capsule. They only get tight at the ends of motion to allow for a significant level of shoulder mobility. Whenever the shoulder is brought to 90 degrees of abduction in external rotation, the superior glenohumeral ligament is tight, the middle glenohumeral ligament is tight, and the inferior glenohumeral ligament is tight [3].

The changed architecture results in numerous significant alterations in the biomechanical features of the shoulder, including an altered centre of rotation, a solid and firm fulcrum for elevation, and increased deltoid muscle tension, which partially compensates for the absence of rotator cuff function [5].

Internal muscle and joint forces are difficult or impossible to quantify experimentally, yet they are critical for biomedical advancement, particularly in implant design, rehabilitation planning, and detecting regions of risk and failure [6].

Broad mobility is harmful to joint stability, rendering the shoulder vulnerable to a variety of dysfunctions and diseases. Codman described scapula-humeral rhythm (SHR) or glenohumeral rhythm (GHR) in 1934 [2].

It illustrates how the SG and GH joints contribute to overall humerothoracic (HT) elevation. SHR is frequently stated as a ratio of GH to SG contribution. It was proposed that the ratio be around 2:1 [7].

Normal SHR is essential for effective shoulder function because aberrant changes in the placement of the scapula relative to the humerus can impede coordinated movement of the shoulder girdle and joint biomechanics, both of which can have consequences lower down the kinetic chain. In a normal shoulder, the humerus and scapula normally move in an established normative 2:1 ratio, such that when the arm accomplishes a full abduction arc to 180°, the shoulder joint rotates 120°, with the scapula contributing 60° of this rotation. SHR is a sensitive measure of shoulder function that gives important information on the scapula and humerus's relative mobility [8].

One of the most interesting planes of motion is 'scapular plane elevation,' often known as 'scaption.' Scaption is one of the most important exercises for stabilising the shoulder joint. It is performed with the patient's arm flexed by 30 degrees and the thumbs positioned upward; the planes of the scapula and humerus are aligned, making SHR and kinematic measurements simpler. Because scaption refers to functional movement patterns involved in shoulder biomechanics, it is an excellent exercise for muscle strengthening in the open chain and beyond the shoulder. Furthermore, scaption movement reduces the likelihood of injury by positioning the larger tubercle's peak beneath the coracoacromial arch's high point. As a result, scaption is regarded as the most efficient movement plane for clinical activities [2].

Shoulder discomfort is a very frequent and debilitating illness. Self-reported shoulder disability questionnaires have proliferated during the last decade [9].

It is the third most prevalent musculoskeletal condition in the general population, accounting for around 16% of all musculoskeletal symptoms [10].

Aging's physiological features, such as degenerating joints, diminishing tissue repair, and joint cartilage loss, may increase the risk of musculoskeletal problems. Individuals over the age of 40 are prone to shoulder joint disorders such as tendinopathy, rotator cuff rupture, adhesive capsulitis, and glenohumeral osteoarthritis [10].

Various studies have identified lifestyle, physical factors, psychological issues, social factors, and incorrect seating as risk factors for neck and shoulder discomfort in students. Moreover, neck and shoulder discomfort in youngsters is regarded as a risk factor for adult health issues [11].

The incidence of shoulder discomfort in the normal community might be as high as 6%-11% in those under the age of 50, rising to 16%-25% in the elderly. Incapacity to work, loss of production, and inability to do household tasks can be a significant burden on both the patient and society. According to Swedish insurance statistics, approximately 18% of total paid sick time for musculoskeletal illnesses in 1994 was spent on neck-shoulder difficulties [12].

Methodology and Materials

Methodology

The study design is observational study and the study area is SKNCOPT Kinesiotherapy lab.

The study population includes normal subjects of all ages who will be participating in this study for the duration of 3 months. Arbatary sampling was done with a sample size of 30 subjects. (May increase or decrease depending upon intra class correlation values).

Inclusion and exclusion criteria

The inclusion criteria of this study consists both genders of all age groups and excludes patients with any previous history of pathology or surgery of the shoulder girdle like fractures. Shoulder impingement syndrome, etc. This study also won't be inclusive of subjects with chronic neck pain and shoulder pain.

Materials

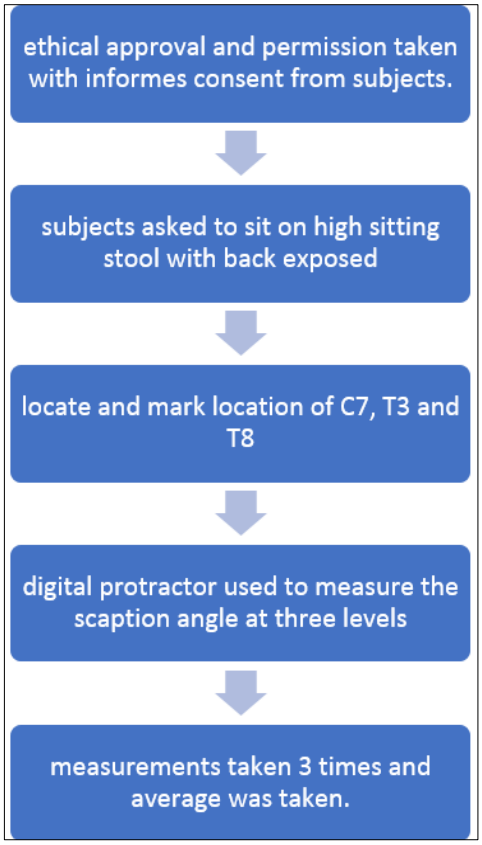
1. High sitting stool
2. Digital protractor
3. Stationaries

Procedure

Ethical approval was taken from the ethical committee. A written informed consent was taken from the subjects and subject information sheets were provided.

Preparation

The subjects were asked to sit on a high sitting stool with hip and knee at 90 degrees. The subjects were then asked to expose their back so that a proper visualization of the vertebrae and scapulae could be done. For the females, they were instructed not to wear tight clothing. Palpation of the spinous process was done to locate the C7, T3 andnT8 vertebrae and were marked. A digital protractor was placed on both the sides to measure the scaption angle and measurements were taken at 3 levels for three times to take out an average.



Results

Table 1: Rater 1 Day 1

Variables	Mean	Standard Deviation
Reading C 7 RT	162.53	13.24
Reading C 7 LT	154.43	13.47
Reading T 3 RT	150.36	16.78
Reading T 3 LT	149.6	15.09
Reading T 8 RT	152.66	17.75
Reading T 8 LT	148.66	15.98

Table 2: Rater 2 Day 1

Variables	Mean	Standard Deviation
Reading C 7 RT	161.7	13.35
Reading C 7 LT	154.16	13.93
Reading T 3 RT	151.7	17.14
Reading T 3 LT	150.9	15.17
Reading T 8 RT	152.63	17.62
Reading T 8 LT	149.36	16.65

Table 3: Rater 1 Day 2

Variables	Mean	Standard Deviation
Reading C 7 RT	162.43	12.25
Reading C 7 LT	157.66	13.51
Reading T 3 RT	152.1	16.39
Reading T 3 LT	150.63	15.68
Reading T 8 RT	254.66	17.13
Reading T 8 LT	151.3	15.79

Table 4: Rater 2 Day 2

Variables	Mean	Standard Deviation
Reading C 7 RT	160.83	13.06
Reading C 7 LT	155.46	12.89
Reading T 3 RT	152.83	16.50
Reading T 3 LT	151.26	15.29
Reading T 8 RT	152.63	17.62
Reading T 8 LT	151.2	15.47

Table 5: Inter class correlation between Rater 1 and Rater 2

Variables	2 C 7 RT	2 C 7 RT	2 T 3 RT	2 T 3 RT	2 T 8 RT	2 T 8 RT
1 C 7 RT	.981					
1 C 7 RT		.875				
1 T 3 RT			.67			
1 T 3 RT				.68		
1 T 8 RT					.73	
1 T 8 RT						.54

Table 6: Inter class correlation of Rater 1 on two successive days

Variables	2 C 7 RT	2 C 7 RT	2 T 3 RT	2 T 3 RT	2 T 8 RT	2 T 8 RT
1 C 7 RT	.89					
1 C 7 RT		.84				
1 T 3 RT			.901			
1 T 3 RT				.829		
1 T 8 RT					.814	
1 T 8 RT						.862

Table 7: Inter class correlation of Rater 2 on two successive Days

Variables	2 C 7 RT	2 C 7 RT	2 T 3 RT	2 T 3 RT	2 T 8 RT	2 T 8 RT
1 C 7 RT	.759					
1 C 7 RT		.782				
1 T 3 RT			.809			
1 T 3 RT				.796		
1 T 8 RT					.790	
1 T 8 RT						.820

Table 8: Interpretation of reliability analysis

<.20	Poor
.21 to.40	Fair
.41 to.60	Moderate
.61 to.80	Good
.81 to 1.00	Very Good

Discussion

This study focuses on the reliable calculation of scapular scaption angle. Scapular Dyskinesis a major contributor in the scaption angle was assessed for its reliability in this study. It concluded that there are no such evident studies and findings on the reliability of Scapular dyskinesis which later proves the same for the scaption angle of the scapula. [13] Infraspinatus muscle plays an important role in the scaption angle where it is proved in this study that the middle partition of the infraspinatus generated the maximum force during the scaption and the other partitions experienced force during the end zones. [14]

Conclusion

The digital protractor is a device that has reliability values ranging from moderate to very good.

Future scope and limitation of study

Future Scope

Can be carried out with large sample size.

Limitation

Small sample size.

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