Intrarater And Interrater Reliability Of Timed Functional Arm And Shoulder Test In Patients With Shoulder Joint Pathology-A Cross-Sectional Study

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Abstract- Shoulder pain is common in general population with various pathologies. Since most of patients have their dominant arm as affected arm, activities of daily living are grossly affected. There are various scales and test used for measuring functionality level of patients. However most of these scales are self reported measures. The Timed functional arm and shoulder test (TFAST) is quick, easy and feasible in measuring different constructs of functional performance that are normally involved in upper extremity impairments. **Aim of the study:** The aim of study was to evaluate inter-rater reliability and intra-rater reliability of Timed Functional Arm and Shoulder Test (TFAST) in patients with shoulder joint pathology. **Study design:** Cross-sectional study. **Methodology:** 62 patients (M=27, F=35) with shoulder pathology were taken. The timed functional arm and shoulder test included three tasks: hand to head and back, wall wash, gallon jug lift. The score of Timed functional arm and shoulder test was taken by two testers for inter rater reliability and by one of testers after a gap of seven days for intra-rater reliability. **Result:** The study demonstrated intra-class correlation coefficient (ICC) with standard error of mean (SEM) of 1.000 and 0.06843 for inter-rater reliability and 0.972 and 0.65491 for Intra-rater reliability. A Bland Altman limit of agreement has also confirmed that inter-rater and intra-rater were within the limits of agreement in 95% of occasions. **Conclusion:** Thus from this study, it could be concluded that the inter-rater and intra-rater reliability of Timed functional arm and shoulder test (TFAST) was "high" in patients with shoulder pathology.

Keywords: Functional test, Reliability, Shoulder Pathology, TFAST

INTRODUCTION

The shoulder joint is one of the more mobile joints in the body and restriction can have a significant effect on function ability **[1, 2, 3]**. Shoulder pain is very common, in fact 1% of adults over the age of 45 present with this symptom to their general practionner each year and due to the complexities of the anatomy and physiology, it is difficult to achieve definite diagnosis using the patient history alone **[4,5,6,7]**. Regular tracking of arm and shoulder functional performance is critical to aid decision making throughout the course of the rehabilitation program, including return-to-work or sport-to-sport decisions **[8]**. Clinical evaluation of patients with shoulder pain and dysfunction presents a unique challenge to the musculoskeletal specialist **[9]**. There exists a large or various numbers of instruments and scales that measure symptoms and function of shoulder **[10].** There are various performance based measures used for athletes **[11, 12, 13, 14, 15, 16, 17]**, none appear to be commonly used for patients with lower-level upper extremity functional demands, for example, non athletes and older adults. The functional test like push up and push up plus test are not feasible for a majority of patients, especially older patients, who commonly have shoulder impairments along with other chronic musculoskeletal conditions **[18, 19]**. The study done by Shah et al **[8]** have developed a timed functional arm and shoulder test and have established reliability in asymptomatic individuals and feasibility in few symptomatic patients. There is lack of literature measuring the reliability of timed functional arm and shoulder test in symptomatic populations. Thus the purpose of this study is to test the intra-rater and inter-rater reliability of Timed Functional Arm and Shoulder test (TFAST) test in patients with shoulder joint pathology.

METHODOLOGY

In this study, 62 symptomatic patients were included. Sample size was calculated based on test-retest designs, and agreement between the raters. According to that if assumptions kept as the observed R will be 0.80 or greater with a lower 1-sided 95% confidence interval i.e. CI=0.10 (i.e., R acceptable $\geq$ 0.70). Therefore 55 patients are required. And with 5% drop out rate, total of 59 patients are required **[20, 21].** Thus, total 62 patients were evaluated with no drop outs. **Inclusion criteria** (a) Age (19-85 years); (b) Both genders i.e. males and females were included; (c) Pain in shoulder joint greater than 3 months; (d) Any affected right or left upper limb patients were included; (d) Subject with any shoulder pathology; (e) Subject willingness to participate. **Exclusion criteria**: (a) Recent injury; (b) Any fixed deformity or contracture; (c) Any disability present; (d) Recent surgery; (e) Recent fracture; (f) Acute cases; (g) Any neurological conditions; (h) Cardiovascular or respiratory problem.

Procedure: A total of 62 patients were selected from out-patient department of S.S. Agrawal institute of physiotherapy, Navsari and Pramukh Swami Hospital, Surat. Basic demographic information, including age, height, weight, dominant and affected side as well as pain intensity by visual analog scale was collected from all the patients. Consent was obtained from all the patients and the patients were screened through various tests, ROM, capsular tightness according to pathology and test presented in table 1.

Table 1: Assessment of shoulder pathology

	CONDITIONS	EXAMINATION
1.	Frozen Shoulder	➢ Apley's scratch test ➢ Capsular Tightness ➢ Range of motion ➢ Joint play
2.	Rotator cuff tear	➢ Empty can test ➢ Full can test ➢ Manual muscle testing
3.	Impingement	➢ Neer impingement test ➢ Hawkins kennedy test ➢ Range of motion
4.	Acromioclavicular joint pathology	➢ Paxison's sign test ➢ Acromioclavicular painful arc
5.	Rheumatoid arthritis	➢ Blood report RA factor positive ➢ Morning stiffness> 3 months
6.	Post operative stiffness	➢ Range of motion ➢ Manual muscle testing
7.	Supraspinatous tear	➢ Empty can test ➢ Full can test ➢ Manual muscle testing of supraspinatus muscle
8.	Mechanical shoulder pain	➢ Range of motion ➢ Manual muscle testing ➢ Joint play

The patients were included for the study with positive test according to pathology, capsular pattern positive, decreased in ROM, weakness of muscle and hypo mobile joint.

The test consisted of 3 basic tasks that encompass the constructs of ROM, endurance, and strength, and took a total of about 10 minutes to complete on both arms. Patients also completed the SPADI and PSS function subscale questionnaires after screening procedure **[22, 23].** All SPADI items are originally scored on a visual analog scale (VAS) from no pain/no difficulty to worst pain imaginable/so difficult. The PSS function subscale is scored from 0 to 60, with lower scores indicating more functional impairments. The entire screening procedure was done by one tester apart from the two testers taking the final test. Measurements were obtained by the two testers in order to test the inter-rater reliability of timed functional arm and shoulder test. Measurements were taken by the same tester on two different days with seven days interval for intra-rater reliability. The test content and procedures were briefly explained to each tester, but no specific training was conducted. The test sessions began with standardized verbal instructions and tester demonstration of each task. The patients were not given any trial or practice. The test was conducted with the procedure as mentioned by shah et al **[8].** The details of task are:

Task 1: HHB (Head to hand and back) Internal and External Rotation

This test was timed for 30 seconds. The test began with the arm at the side, followed by reaching up and touching the back of the head. Any part of the hand, ideally full palm, touching the head was acceptable. After the patient touched the back of the head, the patient brought the arm down to touch the dorsal surface of the hand to the small of the back. The motion was repeated for the duration of the test. Each time the patient touched the back of the head, it was counted as 1 repetition. Total repetitions performed during the task were recorded and the test was repeated for the other arm.

Figure 1: **Hand to head and back**

Task 2: **Wall Wash: Inward and Outward Motion**

This test was timed for 60 seconds in each direction. The patients were instructed to move the hand and arm in circular motions at shoulder height. The centre of the circle was at the shoulder height of the patient, with marks drawn at 6 inches up, down, left, and right to make a circle that was 12 inches in diameter. The test began with the hand holding a scrubber on the top mark. Keeping the scrubber in full contact with the wall, the individual externally rotated (outward motion) the arm so that the scrubber touched each of the 4 marks. Each time the hand passed the top mark, it counted as 1 rotation. Total repetitions were recorded for

60 seconds. The same test was performed for the opposite direction (inward motion or internal rotation), and then both motions were performed on the other arm.

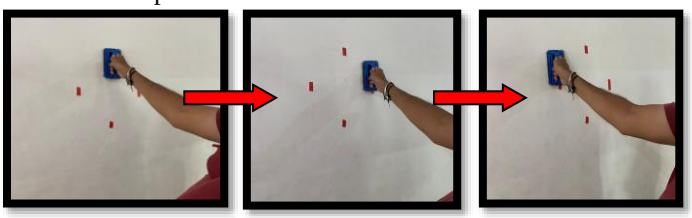

Figure 2: Wall wash

Task 3: Gallon-Jug Lift

This test was timed for 30 seconds. The height of the counter was 36 inches from the floor, and that of the shelf was 20 inches above the counter. The jug used was 3.78 kg in weight. The patient lifted the jug from the counter height, then tapped it lightly on the shelf and immediately brought it back down to the counter height. This movement was repeated as many times as possible in 30 seconds without resting the jug on the shelf. Every time the jug touched the shelf, it counted as 1 repetition. The total repetitions were recorded and the test was repeated on the other arm.

Figure 3: Gallon Jug Lift

Each patient was given these standard instructions: "Please perform all the three tasks as quickly and safely as possible without pain and do as many repetitions as possible within the time limit and can take break if needed. The time will continue to run during your break." The patients were given zero score in case they were not able to perform the task. Rest periods of 30 seconds were provided between all tasks. The test was conducted on unaffected side first followed by affected side. In case of bilateral affected side, the one with less pain was tested first. For each task, total repetitions were recorded and used to calculate the total TFAST score, such that all tasks were represented equally for a 30-second period. For the wall-wash task, the repetitions for the inward and outward directions were added, then divided by 4 to represent 30 seconds of data: [HHB + (wall wash inward and outward/4) + gallon-jug lift] **[8].**

Both the testers recorded the score on the scoring sheet and in order to avoid the exchanging of information, both testers were blinded to the score taken by each other. This procedure was followed for inter-rater reliability.

Figure 4: Testers scoring Timed Functional Arm and Shoulder test for Inter-rater reliability

Patients were not told the scores that they achieved during first test so as to avoid bias on the results of performance level of the subjects, and the procedure was repeated after seven days and data thus obtained was used to calculate for intra-rater reliability. The same testing procedure and equipment was used for all the patients.

Figure 5: Tester scoring Timed Functional Arm and Shoulder test for Intra-rater reliability

Results: In this study, total 62 patients with shoulder pathology were taken.

Table 2 shows the descriptive statistics as mean and standard deviation with minimum and maximum values for all patients.

Table 2: Descriptive statistics of patients

	Minimum	Maximum	Mean	Standard Deviation
Age (years)	19	84	56.35	11.96
Height (meters)	1.44	1.85	1.6297	0.94
Weight (kgs)	47.5	111.5	70.848	13.56
VAS (cms)	0	8.9	5.089	1.86
SPADI	5.4	72.3	35.778	17.45
PSS	20.00	72.0	53.545	9.32

Table 3 showed the descriptive statistics as mean and standard deviation with minimum and maximum values for Timed Functional Arm and Shoulder test (TFAST). Descriptive statistics showed good reliability.

Table 3: Descriptive statistics of TFAST

	Minimum	Maximum	Mean	Standard deviation
Tester 1	0.00	93.00	44.33	18.43
Tester 2	0.00	92.50	44.27	18.43
Retest	11.75	93.00	47.90	18.96

Table 4 showed the intra-class correlation coefficient (ICC) for the inter-rater reliability taken by the tester 1 and tester 2 along with confidence interval (CI) with a p value < 0.05. The ICC value showed good reliability.

Table 4: ICC (Inter-rater reliability) with CI

ICC (inter-rater)	CI (upper)	CI (lower)	p value
1.000	1.000	1.000	0.000

Table 5 showed the intra-class correlation coefficient (ICC) for the intra-rater reliability taken by the tester 1 twice along with confidence interval (CI) with a p value < 0.05. The ICC value showed good reliability.

Table 5: ICC (Intra-rater reliability) with CI

ICC (intra-rater)	CI (upper)	CI (lower)	p value
0.972	0.988	0.906	0.000

Table 6 showed the intra-class correlation coefficient (ICC) for the inter-rater and intra rater reliability of all tasks of TFAST taken by the tester 1 and tester 2 along with confidence interval (CI) with a p value < 0.05. The ICC value showed good reliability.

Table 6: ICC (Intra and Inter -rater reliability)

	Inter -Rater	Intra –Rater	p Value
HHB	1.00 (1.00 - 1.00)	0.917 (0.956 – 0.825)	0.000
WWO	0.998(0.999 – 0.997)	0.977 (0.988 - 0.950)	0.000
WWI	0.999 (0.999 – 0.998)	0.978 (0.988 – 0.958)	0.000
GL	1.000 (1.000 – 1.000)	0.986 (0.993 -0.961)	0.000

The Bland-Altman chart was a scatter plot with the difference of the two measurements for each sample on the vertical axis and the average of the two measurements on the horizontal axis.

Three horizontal reference lines are superimposed on the scatter plot - one line at the average difference between the measurements, along with lines to mark the upper and lower control limits of plus and minus 1.96*sigma, respectively, where sigma was the standard deviation of the measurement differences.

If the two methods were comparable, then differences should be small, with the mean of the differences close to 0 **[24].**

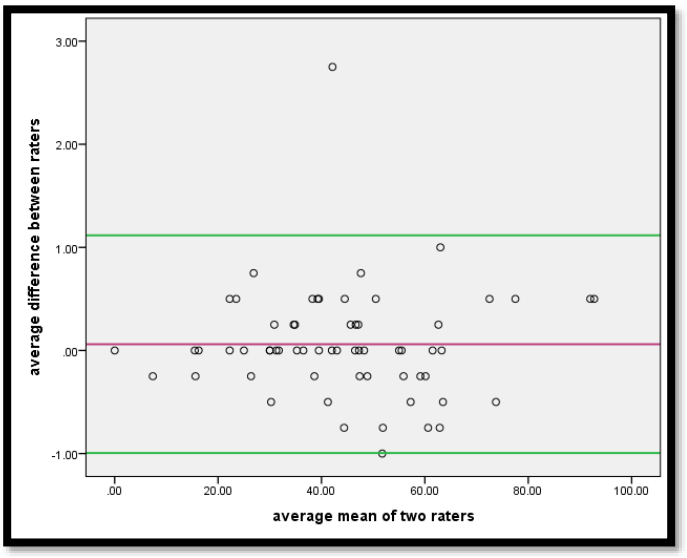

Figure 6: Bland- Altman limits of agreement analysis between two testers

It showed reasonable agreement between the testers as most of the values fall in M ± 2SD ($p<0.05$). It indicates excellent reliability.

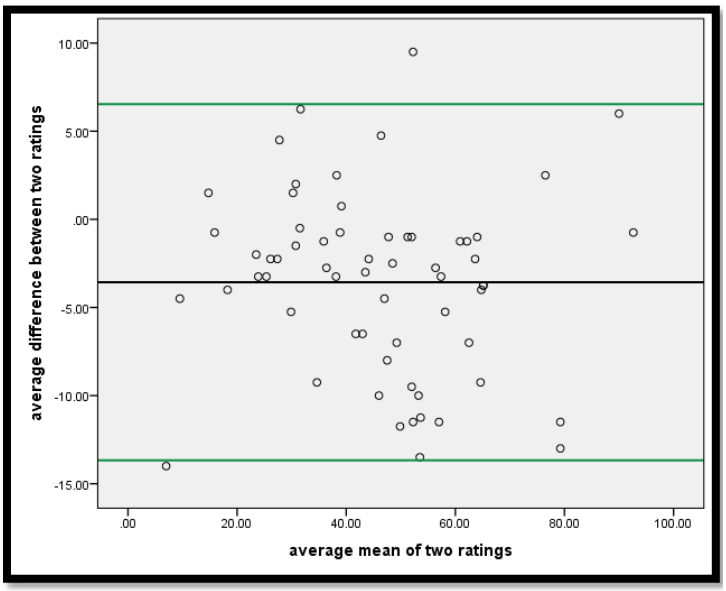

Figure 7: Bland -Altman limits of agreement analysis between scores taken by the same tester twice

It showed reasonable agreement as most of the values fall in M ± 2SD ($p < 0.05$).

The SEM was a measure of absolute reliability- the smaller the SEM the more reliable the measurements **[25, 26].**

The SEM value calculated for variability in measurements between the two testers was 0.06843 which was very small; whereas the variability in measurements of same testers is 0.65491 which was very small. Thus these measurements were reliable.

Table 7: SEM values

	Variability in measurements between two testers	Variability in measurements of same testers
SEM	0.06843	0.65491

The true SEM value for variability in measurements between two testers (0.06843*1.96=0.13412) suggests that any individual value lies within the range of ± 0.13412 TFAST from their measured value.

The true SEM value for variability in measurements of the same testers (0.65491*1.96=1.28362) suggests that any individual value lies within the range ±1.28362 TFAST from their measured value.

Table 8: True SEM Values

	Measurement between two testers	Measurement between same tester
True SEM	0.13412	1.28362

The smallest real difference (SRD) value for variability of measurements between the two testers (1.96*√2*SEM =0.18911) and between the measurements taken by the same tester (1.96*√2*SEM=1.80990) was claimed to be capable of representing the "real" change **[16, 17].**

Table 9: SRD values

	Measurement between two testers	Measurement between same testers
SRD	0.18911	1.80990

Discussion: In this cross-sectional study, which aimed at measuring the intra and inter rater reliability of TFAST (Timed Functional Arm and Shoulder Test) in patients with shoulder pathology by using three different tasks which are hand to head and back, wall wash and gallon-jug lift, the reliability estimates ranged from satisfactory to excellent for both intra-rater and inter rater conditions.

In clinical practice, it was common for patient to be evaluated several times by same or by different examiners. Therefore it was important to know reproducibility of measures and tasks used by the same tester on different occasions as well as by different testers **[27].**

As found in this study, the intra-class correlation coefficient of individual task as well as for total TFAST for the inter- rater reliability and intra-rater reliability was 0.90 or higher for all patients. When compared the total TFAST score, almost 80% of patients have less score of TFAST on affected side compared with unaffected side. This can be because out of total 62 patients (58 right dominant, 4 left dominant) 50% of patients had the affected arm same as dominant which can lead to more problems in activities of daily living and 50% of patients had affected arm as of non-dominant. The variations can be due to difference in level of disability in SPADI and PSS score eg: some patients had severe disability whereas other had mild to moderate disability.

Comparing the individual task, in HHB almost 75% of patients had fewer score on affected side as compared to unaffected. For wall wash, all patients had less score on affected side as compared to unaffected side with wall wash inward score more affected compared to unaffected. For gallon jug lift, affected side score was less compared to unaffected side. In gallon jug lift task 50% of patients could not lift the jug; with the need to reduce the half gallon size for jug lift to be able to complete the task. With

this exception, all the patients were able to complete all tasks without significant pain. When score of individual task as well as total TFAST score was compared with normative values as documented in the article by Shah et al **[8]** all the patients had less score in all three tasks according to age matched group of asymptomatic individuals. Thus this suggests lower level of performance level of all patients and need for proper rehabilitation. Use of the TFAST would most logically be to measure the progress (or deterioration) of a patient or participant over time.

Out of 62 patients, the number of patients in different shoulder pathology are categorized (38= frozen shoulder, 5= rotator cuff, 4= AC joint pathology, 3=supraspinatous tear, 1= impingement, 4= mechanical shoulder pain, 1= rheumatoid arthritis, 1= subacromial bursitis, 5= post operative stiffness. In patients with frozen shoulder, HHB task was more affected as compared to another two tasks. This can be due to the fact that capsular pattern is positive for these patients and patients present with difficulties in external and internal rotation. This is in accordance to the study by Rundquist et al **[28]** which states that external rotation range is limited by anterior capsule, rotator interval capsule and superior glenohumeral ligament and internal rotation range is due to capsular tightness in posterior band of inferior glenohumeral ligament complex. Thus the patients had problems in external and internal rotation range.

For conditions like rotator cuff pathology, mechanical shoulder pain, post operative stiffness, rheumatoid arthritis, impingement syndrome, AC joint pathology, patients had fewer repetitions in wall wash task. The inward and outward motion of shoulder can be affected due to loss of scapular stability and loss of stabilizing function as well as weakness of rotator cuff muscles. The gallon jug lift task was also affected for these patients and almost 50% of patients could not lift the gallon jug which might be due to weight of jug which was unable for the patient to lift due to weakness in strength and endurance of shoulder muscles. There are various self report scales and tools available to measure the functionality level of patients **[10, 29, 30, 31, 32, 33, and 34].** But all the scales and tools have multiple domains. Though these scales are quick and easy tools to understand the patient's perception of his or her pain, disability, and function, which are important outcome measures but self-report measures of function based on a patient's perception often differ from direct measures of functional performance **[8].** The TFAST is quick and easy to perform and takes less time.

There are various tests in the literature to measure functional performance **[11, 12, 13, 14, 15, 16, and 17].** Most of the test evaluates only elevation activities whereas the day to day activities involves rotational activities too. The FIT-HaNSA requires special hardware and equipment and the score is based on the time to complete the test. In contrast, the TFAST scores were calculated based on number of repetitions performed at a self-determined speed within the allotted time; therefore, more repetitions indicated greater power and functional performance.

Tests such as the simple shoulder endurance test **[11]** , function-related tests **[17],** and gallon-jug shelf transfer **[35]** only test 1 construct of function (stability, mobility, and strength, respectively) of the upper extremity. Further, the simple shoulder endurance test demonstrated only moderate test-retest reliability (ICC = 0.59) in a group of asymptomatic individuals. In contrast this study shows excellent reliability in group of symptomatic populations. The tasks were chosen and performed in a specific order based on the understanding that each task would be progressively more difficult compared to the previous one; thus, the TFAST was performed beginning with the HHB task, then the wall-wash tasks, and finally the gallon-jug lift.

Standardisation of protocol was also very necessary for the proper result of inter- and intra-rater reliability. The same protocol with the testing in same setting and environment was followed for inter rater and intra rater reliability. In all test situations there was a learning effect that may improve test results of the second test **[36].** The choice of seven days between tests was made to limit the learning effect. The time period between repetitions of the measures should be long enough to avoid memorisation of data by examiners, but short enough to ensure that there were no clinical changes in the patients. It was recommended that 1 or 2 weeks would be ideal, but there may be reasons for the choice of another interval **[37].**

In this study, the findings of Bland Altman limits of agreement showed excellent inter-rater agreement between the raters indicating that measures related to the tester 1 were in agreement with the tester 2 in 95% of occasions. Similarly, we found excellent intra-rater agreement which means that measures relating to first test were in agreement with the second test in 95% of occasions.

This study also found SEM of 0.06843 for inter rater and 0.65491for intra rater reliability. The true SEM for inter rater is 0.13412 and intra rater is 1.28362 which suggest the absolute measurement error. The SRD value for inter rater and intra rater is 0.18911 and 1.80990 which suggest that there should be at least change of these values so as to say that "real" change has occurred.

The scoring of inter-rater reliability was taken by both the testers together so that duration of contraction or fatigue has homogenous effect on all patients and moreover to avoid the effect of fatigue on the performance level of the patients. If the scores were taken at different times, than it would be difficult to decide that scores were result of true performance of the patient or has fatigue affected the level of performance of patient.

CONCLUSION: Thus from this study, it could be concluded that the inter-rater and intra-rater reliability of Timed functional arm and shoulder test (TFAST) was "high" in patients with shoulder pathology. However the studies should be done taking particular age group of patients and taking patients with same level of disability. Also the studies should be done with particular conditions so that normative values for patient population can be established.

Limitations of study: Data were generalized to all patients with shoulder pathology. Patients of wide age group were taken. Blinding of the testers was not possible. To minimise the error on results of patients, both the testers didn't discuss anything during the recording of the scores.

CONFLICT OF INTEREST: NONE DECLARED

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