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# Inter-Rater and Intra-Rater reliability of the lateral: Scapular slide test in individuals with and without shoulder dysfunction

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**Abstract**
The aim of this research was to study inter-rater and intra-rater reliability of lateral scapular slide test in three different positions; position 1: arm at side, position 2: hands on hip (45º), position 3: 90º shoulder abduction with medial rotation, using a calliper.
100 subjects, 50 with shoulder dysfunction and 50 without shoulder dysfunction, which included individuals of both genders, ranging in age from 19 to 65 years, participated in this study. Method: Two measurements of scapular distance, in each test position were obtained bilaterally. From the bilateral measurements, difference was derived. For interrater reliability, each rater obtained 1 reading of LSST in three positions on same day and for intrarater reliability, LSST was performed again after 48 hours again by the primary investigator (rater 1) in all three test positions.
Intraclass correlation coefficients (ICCs) and the standard error of measurement (SEM) were calculated for intrarater and interrater reliability of the difference in side-to-side measures of scapular distance. Results: The ICCs for interrater reliability were 0.658,0.711, and 0.584 and 0.764, 0.506, and 0.567, respectively, for subjects without and with shoulder dysfunction in all 3 test positions. The ICCs for intra-rater reliability were 0.944, 0.783 and 0.890 and 0.484, 0.556 and 0.573 respectively, for subjects without and with shoulder dysfunction in all 3 test positions. Conclusion: Measurements of scapula position based on the difference in side-to-side scapular distance measures are not very reliable.

**Keywords:** shoulder dysfunction, scapular dyskinesia, lateral scapular slide test, scapular distance, reliability

## 1. Introduction

Shoulder pain is a very prevalent musculoskeletal disorder, with a lifetime prevalence of up to 66.75%. One of the key factors contributing to shoulder pain is physical load on the shoulder complex [1].
The osseous segments of the shoulder complex are the clavicle, scapula, and humerus.These three segments are joined by three interdependent linkages, the sternoclavicular (SC) joint, the acromioclavicular (AC) joint, and the glenohumeral (GH) joint [2].
Asymptomatic function of the shoulder joint complex is highly dependent on the normal relationship between the scapula and the humerus. This relationship is constantly changing due to the natural alterations in the instant center of rotation for the glenohumeral joint and mechanical advantage of the muscles during arm movement [3].
There is sufficient evidence suggesting that scapular positioning and scapular motor control are altered in patients with musculoskeletal disorders, for example, shoulder impingement syndrome, non-traumatic shoulder instability, multidirectional shoulder joint instability, rotator cuff tendinopathy and rotator cuff tears, adhesive capsulitis etc [1].
Alterations in static scapular position and dynamic scapular motion are described as scapular dyskinesis. Classification of dyskinesis is as follows: (A) Prominent inferior medial scapular border- type I. (B) Prominent entire medial scapular border- type II. (C) Excessive superior migration of superior medial scapular border- type III and (D) Normal and symmetric scapular motion- type IV [4].
Abnormal scapular movement or malposition is related to shoulder pathology and therefore it is important to evaluate scapula statically and dynamically There are several methods of scapular assessment. Evaluation of static and dynamic scapular positioning includes measurement of the distance between the posterior border of acromion and the table, the Baylor square technique, measurement of the distance from the medial scapular border to T4 or T3, LSST, analogue and digital inclinometer, 2 and 3 dimensional electromagnetic kinematic testing, all of which have been identified as reliable tests [1].
The functional role of scapula is often misunderstood by clinicians and this lack of awareness can result in incomplete evaluation and diagnosis of impairment of shoulder[5]. In view of this, it is necessary to evaluate potential biomechanical alterations that may contribute to the altered scapular positioning, such as soft tissue tightness, muscle activity, or strength imbalance.
Kibler, described a test to clinically measure static scapular positions called the lateral scapular slide test (LSST). It is used to determine scapular position with the arm abducted 0, 45, and 90 degrees in the coronal plane. Assessment of scapular position is based on the derived difference measurement of bilateral scapular distances [5].
Several researchers determined that the LSST technique holds promise for further studies, has the advantage of measuring in three positions while some authors concluded that the LSST was unreliable. Therefore, the purpose of this study was to determine the inter-rater and intra-rater reliability of LSST

while using a vernier calliper to measure scapular distances [5].

## 2. Materials and Method

The study was approved by the Institutional ethics committee prior to commencement. It was a cross-sectional, observational study including 100 subjects – 50 with shoulder dysfunction and 50 without shoulder dysfunction. Sample size was calculated from the pilot study using Primer Biostatistics software. Individuals with and without shoulder dysfunction in the age group of 19-65 years were included in the study. Individuals having Systemic disease affecting neuromuscular function, inability to maintain 90 degrees of bilateral shoulder abduction, any observed bony deformities, previous shoulder surgery within one year, any medical condition prohibiting the subject to participate in the study and obesity (BMI 29.9 or greater) were excluded.

### 2.1 Procedure

Subjects fulfilling the inclusion criteria and willing to participate in the study were selected. The purpose of the study was explained to them and their written consent was obtained. History was taken, followed by a brief evaluation of the shoulder. Lateral scapular slide test (LSST) was performed.

### 2.2 LSST

Prior to testing, subject's upper body was disrobed so that the spine and both scapulae were in full view of the physical therapist. Two therapists measured each subject during a (first) test session. Rater 1 was a student specializing in musculoskeletal sciences and Rater 2 was a senior physical therapist.

To aid in maintaining a consistent posture during the test session; subjects were instructed to fix their eyes on an object in the examination area. The procedure for data collection followed the precise protocol as described by Kibler.

**Fig 1:** LSST position 1- arm at the sides

Each subject was instructed to actively achieve the first test position (both arms at the sides, in glenohumeral joint neutral). After the position was achieved, the inferior-most aspect of the inferior angle of the scapula and the adjacent spinous process of the reference vertebra in the same horizontal plane was identified through palpation and marked with marker pen by the examiner. Measurements were taken with a vernier caliper (Inferior angle of scapula to adjacent spinous process of reference vertebra). The examiner obtained the measurements bilaterally.

**Fig 2:** Position 2 both hands on ipsilateral hips (45°)

This procedure was repeated again for test position 2 - subject actively placed both hands on the ipsilateral hips (in medial rotation) at 45° of abduction in the coronal plane. After the position was achieved, the inferior-most aspect of the inferior angle of the scapula and the adjacent spinous process of the reference vertebra in the same horizontal plane was identified through palpation and marked with marker pen by the examiner. Measurements were taken with a vernier caliper (Inferior angle of scapula to adjacent spinous process of reference vertebra). The examiner obtained the measurements bilaterally.

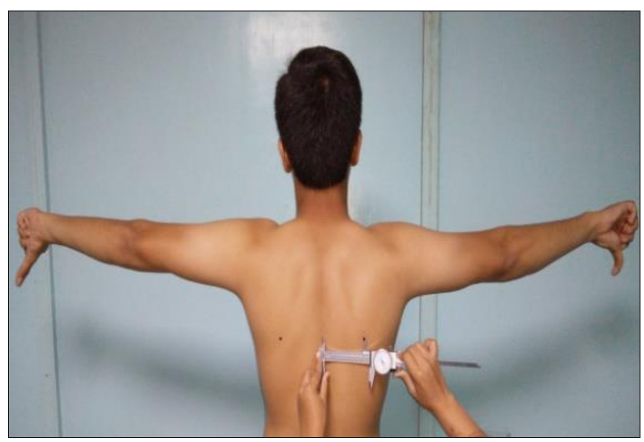

**Fig 3:** Position 3 of abduction 90° and medial rotation

Position 3 - subject actively extended both elbows and placed the upper extremities in a position of maximum medial rotation at 90° of abduction in the coronal plane After the position was achieved, the inferior-most aspect of the inferior angle of the scapula and the adjacent spinous process of the reference vertebra in the same horizontal plane was identified through palpation and marked with marker pen by the examiner. Measurements were taken with a vernier caliper

(Inferior angle of scapula to adjacent spinous process of reference vertebra). The examiner obtained the measurements bilaterally.
After one examiner obtained a complete set of measurements on a subject in all 3 test positions, the entire testing protocol was repeated by the second examiner to evaluate interrater reliability i.e. for interrater reliability, each rater obtained 1 reading of LSST in three positions on same day. For intrarater reliability, LSST was performed again after 48 hours again by the primary investigator (rater 1) in all three test positions.

### 2.3 Data Analysis

**Reliability of the Scapular Distance Measurements**

The ICCs for intrarater reliability of scapular distance measurements ranged from 0.867 to 0.989 (SEM 0.1922 - 0.561 cm) for the subjects without shoulder dysfunction and from 0.769 to 0.943(SEM 0.50-0.79 cm) for the subjects with shoulder dysfunction. The ICCs for interrater reliability ranged from 0.723 to .845 (SEM0.737 -0.911cm) for the subjects without shoulder dysfunction and from 0.665 to 0.814 (SEM0.81–1.02 cm) for the subjects with shoulder dysfunction.

## 3. Results

**Table 1:** Descriptive Statistics for demographic data

| Sr. No: | variable | | Mean | SD | Minimum | Maximum | P value | Significance |
|---|---|---|---|---|---|---|---|---|
| 1 | Age (years) | Shoulder dysfunction group | 42.320 | 12.637 | 19.00 | 64.00 | 0.9620 | Not significant |
| | | Without shoulder dysfunction group | 42.200 | 12.475 | 19.00 | 64.00 | | |
| 2 | BMI | Shoulder dysfunction group | 22.97 | 2.965 | 17.00 | 27.600 | 0.9121 | Not significant |
| | | Without shoulder dysfunction group | 22.93 | 2.877 | 17.030 | 27.600 | | |

There is no significant difference in age and BMI between the two groups.

**Table 2:** Means, Standard Deviations, and Ranges for Subjects With and Without Shoulder dysfunction for Scapular Difference Measurements for the Three Test Position

| | Without shoulder dysfunction group | | Shoulder dysfunction group | | | |
|---|---|---|---|---|---|---|
| **Measures** | **Mean** | **SD** | **Mean** | **SD** | **P value** | **Significance** |
| Position 1 | 0.656 | 0.6447 | 0.466 | 0.5240 | 0.069 | Not significant |
| Position 2 | 0.604 | 0.5455 | 0.402 | 0.4821 | 0.0465 | Significant |
| Position 3 | 0.814 | 0.6446 | 0.5 | 0.4389 | 0.0109 | Significant |

There is no significance difference in position 1 while the difference is significant in position 2and 3 when comparing the two groups (rater 1 measurements)

**Table 3:** Intrarater Reliability for Measurements of Scapular Difference for Subjects With and Without Shoulder dysfunction.

| | Shoulder dysfunction group | | | Without shoulder dysfunction group | | |
|---|---|---|---|---|---|---|
| Test position | ICC | 95% CI | SEM | ICC | 95% CI | SEM |
| Position 1 | 0.484 | 0.242-0.670 | 0.8403 | 0.944 | 0.903-0.968 | 0.2380 |
| Position 2 | 0.556 | 0.332-0.721 | 0.6324 | 0.783 | 0.646-0.871 | 0.4065 |
| Position 3 | 0.573 | 0.355-0.733 | 0.7382 | 0.890 | 0.814-0.936 | 0.29063 |

Intra-rater reliability of LSST in shoulder dysfunction group is poor and in without shoulder dysfunction group is good.

**Table 4:** Interrater Reliability for Measurements of Scapular Difference for Subjects With and Without Shoulder dysfunction.

| | Shoulder dysfunction group | | | Without shoulder dysfunction group | | |
|---|---|---|---|---|---|---|
| **Test position** | **ICC** | **95% CI** | **SEM** | **ICC** | **95% CI** | **SEM** |
| Position 1 | 0.764 | 0.620-0.859 | 0.600 | 0.658 | 0.457-0.793 | 0.6180 |
| Position 2 | 0.506 | 0.272-0.685 | 0.7065 | 0.711 | 0.535-0.827 | 0.4898 |
| Position 3 | 0.567 | 0.347-0.728 | 0.7366 | 0.584 | 0.363-0.742 | 0.6175 |

Interrater reliability of LSST is poor in both the groups.

**Table 5:** Means, Mean Differences, Standard Deviations, and Results of Tests of Statistical Significance for Differences in Measurements of Scapular Distance Between affected and non-affected Sides in the Subjects with Shoulder dysfunction.

| Side /test position | Mean | SD | Sample size | P value | Significance |
|---|---|---|---|---|---|
| Position 1 AFF | 8.599 | 0.9867 | 50 | 0.0043 | Significant |
| NAFF | 8.225 | 1.002 | 50 | | |
| Position 2 AFF | 8.658 | 1.094 | 50 | 0.0012 | Significant |
| NAFF | 8.344 | 0.9595 | 50 | | |
| Position 3 AFF | 9.503 | 1.093 | 50 | <0.0001 | Significant |
| NAFF | 9.169 | 1.048 | 50 | | |

There is significant difference between affected and non-affected sides in position 1, 2 and 3 when comparing within the groups (rater 1 measurements)

**Table 6:** Means, Mean Differences, Standard Deviations, and Results of Tests of Statistical Significance for Differences in Measurements of Scapular Distance Between affected and none affected Sides in the Subjects with Shoulder dysfunction.

| Side /test position | Mean | SD | Sample size | P value | Significance |
|---|---|---|---|---|---|
| Position 1 DOM | 8.254 | 0.8758 | 50 | 0.4257 | Not Significant |
| NDOM | 8.167 | 0.9191 | 50 | | |
| Position 2 DOM | 8.445 | 0.9725 | 50 | 0.0026 | Significant |
| NDOM | 8.233 | 0.9593 | 50 | | |
| Position 3 DOM | 9.198 | 0.8746 | 50 | 0.0211 | Significant |
| NDOM | 8.986 | 0.9308 | 50 | | |

There is no significant difference between dominant and non-dominant sides in position 1 while there is significant difference between dominant and non-dominant side in position 2 and 3 when comparing within the groups (rater 1 measurements)

## 4. Discussion

The LSST has been used to assess absolute scapular position and scapular asymmetry, which may be indicative of shoulder dysfunction. It is a relatively simple procedure that is neither time intensive nor expensive. Results of previous reliability studies of scapular positioning have demonstrated that measurements of linear distance related to the scapula can be reliable but some researchers determined that the LSST may be too variable and unreliable [5].

Present study was conducted on 100 subjects, 50 subjects with shoulder dysfunction and 50 subjects without shoulder dysfunction. The subjects included were age, gender and BMI matched in both the groups. Inter- rater and intra-rater reliability of lateral scapular slide test in three positions were assessed in both the groups.

**Results indicate that**

- Inter-rater reliability for LSST is fair for position 1 and poor for position 2 and 3 while intra-rater reliability is poor for all 3 position in shoulder dysfunction group.

**Without shoulder dysfunction group**

- Inter- rater reliability of LSST is poor for position1 and 3 while fair for postion 2 while intra-rater reliability is excellent for position 1, fair for position 2 and good for position 3 in without shoulder dysfunction group.

**Intra-rater reliability values were higher than inter–rater reliability values for scapular position (both groups ) and scapular asymmetry(Without shoulder dysfunction group) while values were similar for shoulder dysfunction group**

Similar result was observed by Thomas Curtis *et al.* (2006) [5], Odom J *et al.* (2001) [6], A Shadmehr *et al.* (2008) [7], Gibson *et al.* (1995) [8] and Leen T'Jonck (1996) [9] who found higher values for intra-rater reliability when compared to inter-rater reliability.

Gibson *et al.* stated that, Inter-rater reliability values were lower due to differences in measurement to the inferior angle of the scapula by the individual raters. The landmark i.e inferior angle assumes different contours on different subjects and typically describes an arc rather than a point. One rater may be measuring vertebral border of inferior angle of scapula while other measures most inferior point on the scapula [8].

He further stated that lack of discrete standardised point on the inferior angle of scapula, increased muscularity or increased sub cutaneous fat may lead to differences between raters[8].

Differences in measurement technique and experience of the raters may also partially account for the lower inter-reliability values.

**Reliability values were higher for the subjects without shoulder dysfunction than for the subjects with shoulder dysfunction in all test positions.**

The results were in accordance with that observed by Odom J *et al.* (2001)[6] who found higher values for reliability in subjects without shoulder dysfunction when compared to subjects with shoulder dysfunction.

According to the results documented by Thomas Curtis *et al.* there was no difference in reliability values between shoulder dysfunction group and without shoulder dysfunction group. He attributed this to the experience of the raters in their study, which averaged over 22 years and the fact that they were familiar with the LSST [5].

**In all positions reliability values scapular asymmetry were similarly reduced in shoulder dysfunction group.**

Odom J *et al.* (2001) [6], Gibson *et al.* (1995) [8] and Thomas Curtis (2006) [5] observed similar result, with decrease in reliability values from test position 1 to test position 3.

Two of the LSST arm positions, 0°(arm by the side) and 45°(hands on hip) are static in nature while the 90° position is dynamic in nature i.e the subject must actively maintain the 90° test position.

The inferior angle of the scapula is more difficult to palpate as the shoulder moves toward the 90° position because the scapula becomes increasingly congruent with the thoracic wall(scapula rotates and protracts) as the glenohumeral angle moves toward 90° and beyond.

In the two static positions, the muscles are relaxed and more compliant. However, in the 90° position, the muscles are in a state of isometric contraction, increasing muscle stiffness, making the scapula more difficult to palpate [5].

According to Gibson *et al.* (1995), palpation of landmarks is difficult at times, specially position 2 and 3 due to increasing approximation of inferior angle of scapula against the rib cage. In position 3, dorsal muscle contraction produced by active humeral abduction makes the inferior angle of scapula more difficult to palpate accurately [8].

Thomas Curtis explained that Test position 3 challenges scapular stability by abduction and internal rotation of the humerus at 90 degrees and closely approximating the humeral head against the coracoacromial hood [5].

The scapular stabilizers, particularly the serratus anterior, are forced to contract and upwardly rotate the scapula to prevent impingement of suprahumeral structures. Thus, test position 3 challenges the muscular force couple and, therefore, one may see more variability with scapular positioning.

Also, while maintaining position 3, impingement of pain sensitive structures may occur, thus increasing the variability of the measures [5].

A Shadmehr *et al.* stated that the LSST is essentially a measurement of a single planar, two dimensional lateral movement of the scapula. Scapular motion, especially as the arm reaches higher level of abduction, involves three dimensional motions that are not in the plane of the measurement by calliper. This is probably the major reason for the inconsistency in the findings with progressive arm elevation angles. Moreover, the lack of a distinct reference point on the inferior angle of the scapula may have contributed to variation in measurements [7].

**In position 1, 2 and 3 there is significant difference in scapular position between affected and non affected limbs. Affected scapula is more lateral.**

Burkhart *et al.* reported that injured overhead athletes typically present with an asymmetrically dropped shoulder on the affected side, caused by increased scapular protraction, anterior tilting, and internal rotation [10].

Nihan Ozunlu *et al.* stated that, decreased scapular upward rotation and increased protraction, internal rotation, and anterior tipping on the injured side (the dominant side in most cases) was commonly found in patients with various shoulder conditions [35].

In a study conducted by Ferruh Taspinar *et al.* they stated that their results were in agreement with those in the literature, showing that pathologies such as impingement, rotator cuff tear inflammation, and disc herniation all cause scapular asymmetry and consequently protraction in the affected extremity [11].

DiVeta *et al.* in 1990 reported that scapular protraction leads to an abnormal position of the scapula and causes an increase in the distance between the inferior angle of the scapula and the spinous process of the vertebra [12].

**In position 2 and 3, there is significant difference in scapula position between dominant and non dominant limbs. Dominant scapula is more lateral. In position 1, difference in scapula position is not significant.**

Magee[13], Kelley[14], and Meister [15] reported that scapular resting position is highly variable depending on posture and hand dominance. Gibson *et al.* found consistently larger means for the dominant extremity when compared to the non dominant side, in all positions of LSST, in healthy non athletic subjects [8].

Greenfield [16] compared posture between healthy individuals without shoulder pain and patients with shoulder overuse injuries. Subjects were measured in the orthoposition and self-balanced position of the head, which are similar to position 1 of the LSST. The investigators found no significant difference in scapular symmetry between the patient group and the healthy group. This finding demonstrated that scapular asymmetry exists in an asymptomatic sample supporting the results of the study conducted by Perry Koslow *et al.* [17]

Andrews *et al.* reported that arm dominance leads to asymmetry between the size and contours of the different shoulder girdle muscles [18]. King *et al.* described over development of the musculature in the dominant extremity as being common in the throwing athlete [19]. Furthermore, various authors document asymmetry in shoulder girdle position as being associated with shoulder musculature hypertrophy in overhead athletes.

Increased scapular protraction, anterior tilting, and internal rotation was observed in older, healthy overhead athletes by Nihan Ozunlu and others [20]. This finding suggested that the asymmetry observed in old players might not necessarily be related to an abnormality. A pathologic threshold at which an asymmetric scapular posture becomes problematic might exist.

The investigation on LSST specificity, conducted by Perry Koslow supports the above research finding suggesting that asymmetry is not necessarily an indication of dysfunction[17].

In addition, Magee noted that upon relaxation of the upper extremity musculature, as in LSST position 1, the distance between the spinous process and the medial border of the scapula is widened on the dominant side [13].

These findings were also supported by the work of Sobush *et al.*, who suggested a slightly more medial and cranial location of the non dominant scapula, although no statistically significant differences were found between the position of the dominant and non dominant scapula [21].

- In all positions, LSST measures for affected scapula are higher followed by dominant, non affected and non dominant scapula.
- In position 1, there is significant difference in LSST measures between affected scapula and dominant as well as non dominant scapula.
- In position 2, there is significant difference in LSST measures between affected scapula and non dominant scapula.
- In position 3, there is significant difference in LSST measures between affected and dominant and non dominant scapula as well as non dominant and non affected scapula.

**Therefore, it can be inferred that, on comparing both groups, scapular distance on the affected side is significantly increased as compared to dominant and non dominant sides in all three positions**.

Ferruh Taspinar *et al.* (2013) stated that asymmetry of the scapula and protraction of the affected scapula was observed in patients with cervical and shoulder pathology. The scapular asymmetry and shoulder protraction on the affected side in the patient group was significantly higher ($p < 0.05$) than control group. On the unaffected side, there was no difference in shoulder protraction ($p > 0.05$) [22].

In 1990, DiVeta *et al.* reported that scapular protraction leads to an abnormal position of the scapula and causes an increase in the distance between the inferior angle of the scapula and the spinous process of the vertebra [12].

SEM for inter-rater reliability is higher than intra-rater reliability in all 3 positions for affected and non affected sides in shoulder dysfunction group.

SEM for inter-rater reliability is higher than intra-rater reliability in all 3 positions for dominant and non dominant sides in without shoulder dysfunction group.

SEM values increase from position 1 to 3 in both groups.

SEM values are higher in shoulder dysfunction group than without shoulder dysfunction group.

Decrease in ICC increases SEM.

The SEM reflects the error, with which scapular position and asymmetry can be measured, with smaller errors reflecting more reliable measurements.

In his study, Odom J *et al.* observed that SEM for inter-rater reliability were higher than those for intra-rater reliability in all cases and SEM for inter-rater reliability (subjects with and without shoulder pathology) increased consistently from the test position 1 to test position [36].

Gibson *et al.* (1995) also found similar results as present study with SEM values being increased for inter-rater reliability when compared to intra-rater reliability (subjects without shoulder pathology) and SEM increasing progressively from position [1-38].

The results observed by Thomas Curtis *et al.* (2006) in his study on LSST reliability in subjects (with and without shoulder pathology), showed that SEM increases from position [1-35].

In a systematic review, A Wright *et al.*, reported that the presence of scapular dyskinesis or abnormal scapular position is not able to diagnose the presence or absence of shoulder pain [23].

According to the consensus statement (2013) from the 'scapular summit', scapular asymmetry (side-to-side differences) is a common finding in healthy individuals, further complicating the ability to identify when scapular motion or position is abnormal. Based on evidence to date, scapular dyskinesis (dynamic) and position (static) tests are not helpful to completely diagnose shoulder pain and therefore should be considered as impairment assessment tools.

Several limitations existed in this study, It was limited to a single geographical area, Blinding was not done and Order of rater was not randomized.

## 5. Conclusion

The study concluded that, scapula distance method is reliable as it has fair to excellent inter-rater and intra-rater reliability in both the groups but scapula difference is not reliable measures as it has poor to fair inter-rater and intra-rater reliability in both the groups. The measurements obtained with the LSST cannot be used to reliably assess the presence or magnitude of scapular asymmetry.

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