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Clinical Examination of the Unstable Shoulder

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Contents

Abstract

The clinical history is usually a very helpful guide for identifying frank traumatic glenohumeral joint dislocations. Glenohumeral dislocation most commonly occurs in the anterior direction (>95%) with the shoulder forcibly abducted and externally rotated. Atraumatic, multidirectional and subtler glenohumeral instability are often harder to diagnose. The presence of a sulcus of two or more centimetres beneath the acromion while pulling the arm inferiorly is predictive of multidirectional instability [likelihood ratio (LR) 9]. The O'Brien's sign is helpful for diagnosing superior labral detachment (LR 3 to 50). Load and shift tests, when positive, are extremely predictive for instability (LR >80), but when absent are poor at ruling out posterior and inferior instability. The apprehension sign and its variations (augmentation, relocation and release) have reasonable inter-examiner reliability (ICC **((Author: intraclass correlation coefficient?))** 0.5 to 0.7) and are highly predictive for anterior instability (LR 8 to 100).

The shoulder is the most commonly dislocated joint in the body,[1,2] and is particularly vulnerable to sporting injury.[3,4] The ease of dislocation of the shoulder is caused by the lack of restraint required to enable the shoulder to obtain its range of motion. The stability of the shoulder is derived from a complex interaction of the bony, passive and active restraints.[5] Methods for relocating the shoulder have been found in ancient Egyptian frescos, as well as amongst the writings of the ancient Greeks.[6]

1. Shoulder Anatomy

The shoulder joint consists of four articulations: the sternoclavicular joint, acromioclavicular joint, glenohumeral joint and scapulothoracic articulation.[7] The glenoid is shaped much like an inverted comma,[8] with an average superior-inferior length of 35mm and an average anterior-posterior length of 25mm.[7] Its radius of curvature is greater than that of the humeral head,[8] which is much larger with average anterior-inferior and superior-posterior diameters of 45 and 48mm, respectively.[7] As such, the humeral head has a diameter 1.5- to 2-fold and a surface area 3-fold that of the glenoid.[8] This disparity of size gives the joint its large range of motion – with a concomitant cost in joint stability. The depth of the glenoid is approximately doubled by the presence of a cartilaginous labrum[5] that acts as a 'chock block',[9,10] preventing excessive movement as well as providing an attachment point for most of the ligaments.[11] The glenohumeral ligaments are discrete thickenings of the joint capsule which have a number of normal variances.[11] The capsule has a surface area almost twice that of the humeral head,[11] most of which is in the inferior capsular pouch. Despite the large surface area of the capsule, the joint volume is low[10] (~1ml) and there is a negative pressure inside the capsule[12,13] which is thought to be maintained by an osmotic gradient.[10] The glenohumeral joint is further stabilised by the rotator cuff,[8-10,12,14-16] the tendons of which are partially adherent to the glenohumeral ligaments,[5] acting to tension these ligaments as well as acting via their bony attachments to the scapula and humerus.

2. Early Research

Perthes[17] in 1906, was one of the first surgeons to note the presence of a detachment of the anterior labrum in patients with recurrent anterior instability. Bankart[18,19] described a method for surgically repairing this lesion that now bears his name. Inman et al.[20] reported on research into the functioning of the joint in 1944, focusing on how the articulations of the shoulder work together throughout the range of the movement of the joint. In 1950, Townley[21] described a capsular mechanism of recurrent instability, whereby tightness of one section of the capsule results in instability in the opposite direction. This theory was a precursor to Warren's[22] circle theory of instability. In 1956, Rowe[23] reported on an epidemiological study on the prognosis of shoulder dislocations, showing that younger people are more likely to have recurrent instability following a dislocation.

3. Laxity Versus Instability

Shoulder laxity is a description of the looseness of the passive stabilisers of the shoulder. Instability has been defined as symptoms secondary to in-

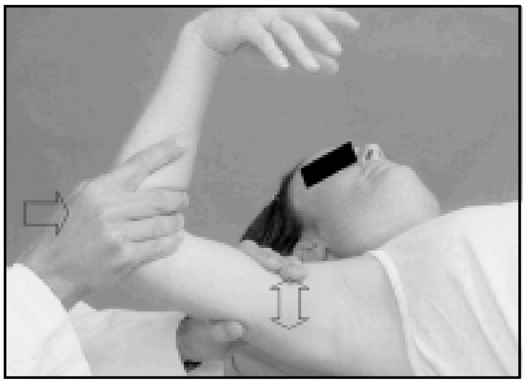

Fig. 1. Load and shift test.[30] Anterior translation is most effectively tested with the patient supine, with the scapula on the edge of the examining table but with the humeral head free to be translated anteriorly and posteriorly. Hold the patient's arm as illustrated. Load the humeral head into the glenoid and then translate the humeral head in the anterior and posterior directions. The patient should be relaxed.

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Table I. Validity of clinical tests for shoulder instability

Test	Sensitivity (%)	Specificity (%)	Likelihood ratio (+)[a]	Likelihood ratio (–)[b]	Reference
Load and shift					
Anterior	50	100	>100	0.5	29
Posterior	14	100	>100	0.9	29
Inferior	8	100	80	0.9	29
Sulcus sign[c]					
>1cm	72	85	5	0.3	28
>2cm	28	97	9	0.7	28
Provocative tests					
Apprehension	NA	NA	NA	NA	
Augmentation	68	100	>100	0.3	39
Relocation	50	100	>100	0.5	39
Release	92	89	8	0.1	39

a Likelihood ratio expresses the odds that a positive test result would occur in a patient with, as opposed to a patient without, shoulder instability. A test is considered useful if a likelihood ratio is >10.[38]

b Likelihood ratio for a negative test result.

c With respect to predicting multidirectional instability.

NA = ((Author: not applicable?)) .

creased laxity,[8] that is, symptoms that are the result of poor control of the movement of the humerus on the glenoid. The laxity of normal shoulders is not known.[22] Studies[1,24] to date in this area have focused on high school and college age students. The laxity of the glenohumeral joint decreases as the ligaments tighten with age.[10,25]

Examination under anaesthesia is the ultimate ‘gold standard’ for assessing shoulder laxity. Under anaesthesia, the passive stabilisers of the shoulder are tested in isolation.[26] Cofield et al.[27] and Oliashirazi et al.[26] have demonstrated a significant difference between stable and anteriorly unstable shoulders on laxity testing under anaesthesia. We[28,29] have found a significant difference in the laxity of unstable shoulders when compared with the shoulders of patients with other symptomatic shoulder conditions.

4. Laxity Examinations

Laxity examinations are shoulder examinations that by definition should not cause symptoms in the patient. Often, however, patients with recurrent instability have significant guarding which makes the load and shift tests, in particular, difficult to perform.

4.1 Load and Shift Test

A number of variations of the load and shift test[30] have been described, differing in the arm

Table II. Interobserver reliability of clinical tests for shoulder instability

Test	ICC[a]	Significance (p-value)	References
Load and shift[b]			
Anterior	0.72	<0.0001	28,36
Posterior	0.42	NS	28,36
Inferior	0.65	0.0003	28,36
Sulcus sign	0.60	<0.0001	28,36
Provocative tests[c]			
Apprehension	0.47	0.0002	28,36
Augmentation	0.48	0.0003	28,36
Relocation	0.71	<0.0001	28,36
Release	0.63	<0.0001	28,36

a Intraclass correlation coefficient (3,1).

b At 90° of abduction.

c Using apprehension, not pain, as being indicative of a positive test.

NS = ((Author: not significant?)).

Fig. 2. Anterior drawer test.[40] The patient is examined supine with the examiner facing the affected shoulder. When examining the right shoulder, the right hand of the patient is held under the examiner's left axilla by the examiner clamping their arm against their side. The shoulder is held in 80 to 120° of abduction, 0 to 20° of flexion and 0 to 30° of lateral rotation. The examiner holds the patient's scapula with their left hand while grasping the patient's upper arm and drawing the humeral head anteriorly with their right hand.

position used and whether the patient was seated or supine for the examination.[31,32] The principle of the test is to evaluate the amount of translation of the humeral head on the glenoid. Several methods for grading the load and shift test have been used.[14,33,34] The most common, however, is a modified Hawkins grading,[32] where the assessment has a clinical basis.[1] Grade 0 has little to no movement; grade 1 is when the humeral head rides up onto the glenoid rim; grade 2 is when the humeral head can be dislocated, but spontaneously relocates; and grade 3 is when the humeral head does not relocate when the pressure is removed. Protzman[35] described a test in 1980 that was very similar to the now more commonly used load and shift test. The patient was examined in the seated position with the arm resting on the examiner's hip. The examiner placed one hand on the posterior joint margin to press the humeral head antero-inferiorly and the other hand in the patient's axilla, to feel for any movement.

When the patient is tested in the supine position, the patient is usually positioned so that the centre of their scapula is on the edge of the bed, while the humeral head is off the bed to facilitate glenohumeral rather than scapulothoracic translation (figure 1). The patient's arm is grasped with both hands, one near the humeral head, one grasping the forearm near the elbow. The distal hand loads the humeral head into the glenoid before the more proximal hand attempting to shift the humeral head. The amount of shift is difficult to determine without loading the humeral head. We[28,36] found the load and shift test to be highly specific (100%), but not particularly sensitive (8 to 50%; **table I**). The two most commonly described positions in which the arm is held are all in the scapular plane, in 20° abduction and flexion and in 90° abduction. The reliability of the load and shift test has been assessed by Levy et al.[37] in 1999, who reported the test to have poor reliability. We have found that the test was of moderate to good reliability and of clinically useful validity in the anterior and posterior directions, and had good reliability, but poor validity in the inferior direction. Levy used the 90° abducted position for assessment, while we used all three variations of the load and shift test (0° abducted while seated, 20° and 90° abducted in the supine position) [**table II**].

4.2 Drawer Tests

The anterior and posterior drawer tests were described by Gerber and Ganz[40] in 1984. These tests have been used to assess laxity by some investigators instead of the load and shift test. The anterior drawer test was described with the patient supine (figure 2). The examiner would stand facing the affected shoulder. If the left shoulder was to be examined, the left hand of the patient being examined was held under the examiner's right axilla by the examiner clamping their arm against their side. The shoulder was held in 80 to 120° of abduction, 0 to 20° of flexion and 0 to 30° of lateral rotation. The examiner held the patient's scapula with their right hand while grasping the patient's upper arm and drawing the humeral head anteriorly with their left hand. The posterior drawer test was described with the patient supine (figure 3). The patient's forearm was grasped with one hand and placed into 80 to 120° abduction and 20 to 30° flexion with the elbow flexed to 120°. The other hand grasped the scapula, fingers on the scapula spine, thumb lateral

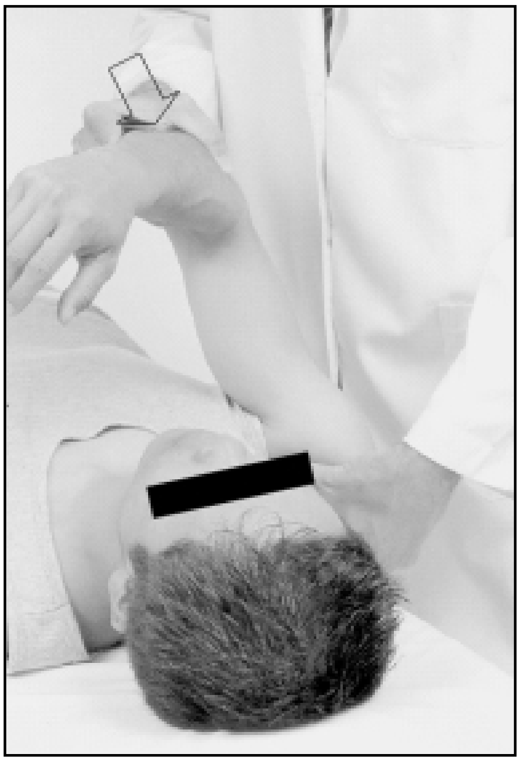

Fig. 3. Posterior drawer test.[40] The patient is supine. The patient's forearm is grasped with one hand and placed into 80 to 120° abduction and 20 to 30° flexion with the elbow flexed to 120°. The other hand grasps the scapula, fingers on the scapula spine, thumb lateral to the coracoid process.[36] The arm is flexed to 60 to 80° while the thumb of the other hand attempts to subluxate the humeral head posteriorly. In a positive test the thumb is felt to slide past the coracoid.

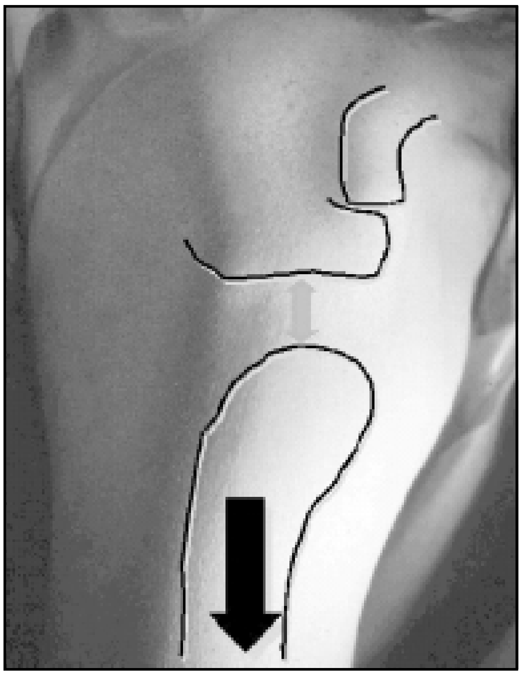

Fig. 4. Sulcus sign.[41] While the patient is seated and relaxed, the patient's elbow is pulled inferiorly. If the patient has a symptomatic shoulder and a sulcus of >2cm develops beneath the acromion, the patient is highly likely to have a multidirectional instability.[28,29]

to the coracoid process.[36] The arm was flexed to 60 to 80° while the thumb of the other hand attempted to subluxate the humeral head posteriorly. In a positive test the thumb was felt to slide past the coracoid. Load and shift style grading of the drawer tests has been reported. This test is yet to be assessed as to its validity and reliability.

4.3 Sulcus Sign

Neer and Foster[41] originally described the sulcus sign as the stress test. Recent biomechanical studies have demonstrated that this manoeuvre tests the superior glenohumeral ligament.[5,11] The test is performed with the arm at rest by the patient's side. The elbow[40] is grasped and pulled inferiorly (figure 4). If the test is positive a sulcus (dimple) appears in the subacromial region as the humeral head translates in the inferior direction.

The sulcus sign was originally described as a test to determine the presence of multidirectional instability.[41] Since then authors have questioned the interpretation of its findings, with some suggesting that only sulci of a certain size or higher should be interpreted as an indication for multidirectional instability.[1,42] The sulcus sign has also been used as one of a series of tests for generalised ligamentous laxity[25] – one of the conditions that Neer **((Author: reference?))** originally ascribed as a cause of multidirectional instability. We[28,29] have found that the sulcus sign was more sensitive, and equally as specific as the load and shift test in assessing inferior laxity. The test has had a number of grading systems described for it;[1,42] **((Author: please confirm references))** all, however, rely on the measurement of the sulcus in centimetres. We[28,29] found the sulcus sign to have a specificity of 97% for multidirectional instability when the sulcus is 2 or more centimetres (table I). However, using this strict criteria the sensitivity is poor (28%), that is, using this criteria alone 72% of patients with multidirectional instability would be missed. There is also evidence for significant interobserver error in the assessment of the size of the sulcus (table II).

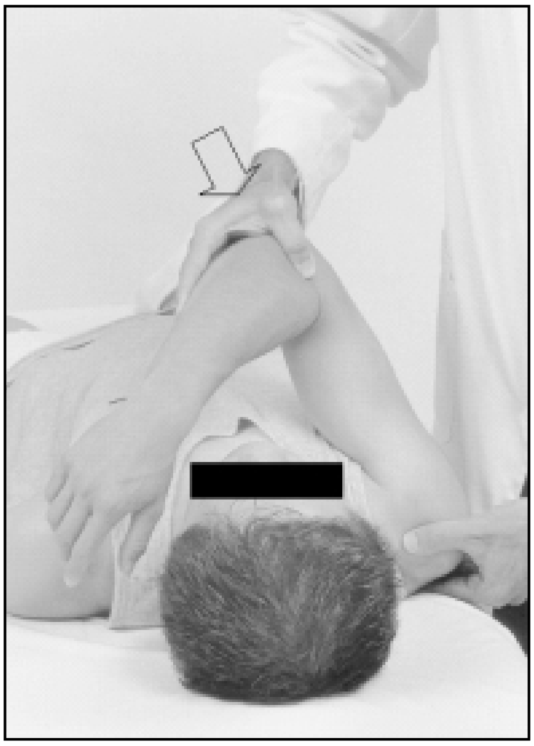

Fig. 5. Posterior subluxation test.[31] The test is performed by placing the patient's arm in adduction, internal rotation and 70 to 90° flexion with one hand which then applies a posteriorly directed force along the arm. The other hand is placed over the shoulder with the fingers on the posterior joint line. In a positive test, the humeral head is felt to subluxate posteriorly. The arm is then slowly horizontally abducted and externally rotated until the humeral head is felt to clunk back into position.

4.4 Posterior Subluxation Test

Clarnette and Miniaci[31] described a posterior subluxation test in 1998 (figure 5). This test was performed by placing the patient's arm in adduction, internal rotation and 70 to 90° flexion with one hand which then applied a posteriorly directed force along the arm. The other hand was placed over the shoulder with the fingers on the posterior joint line. In a positive test, the humeral head was felt to subluxate posteriorly. The arm was then slowly horizontally abducted and externally rotated until the humeral head was felt to clunk back into position. This test is yet to be validated.

5. Provocative Tests

These tests use patient symptoms to define a positive test, and, as such they are tests of symptomatic shoulder laxity.

In the anterior direction there are four tests that have been described (figure 6). The apprehension test, as originally described is now more commonly referred to as the augmentation test, with a less rigourous test bearing the name 'apprehension test'. However, some authors[39] use the originally described test when performing their research, so care must be taken when evaluating results to determine which technique was used.

5.1 Apprehension/Augmentation Tests

Rowe and Zarins[43] originally described the apprehension test in 1981. In the original article, the

Fig. 6. Provocative tests. The patient is positioned as per the load and shift test (figure 1). The arm is placed in a position to reproduce the symptoms of anterior instability, that is, abduction and external rotation. (**a**) Apprehension test:[43] the test is most reliable when the patient expresses apprehension that the shoulder will 'come out' rather than pain. (**b**) Augmentation:[12] there is increased apprehension when the humeral head is translated anteriorly. (**c**) Relocation:[44] there is decreased apprehension when the humeral head is translated posteriorly. (**d**) Release:[45] there is increased apprehension when posteriorly directed pressure on the humeral head is released.

patient was tested in the supine position, lying so that the centre of the scapula was on the edge of the bed. The arm was positioned in 90° abduction and external rotation, then further extended and externally rotated to the end range of motion. The examiner then applied an anteriorly directed force to the humeral head, feeling the joint line for any movement. The test was considered positive if the patient became apprehensive and either tightened up to prevent further movement or told the examiner to stop as they felt their arm was about to dislocate. Silliman and Hawkins[12] gave this procedure the name augmentation test in 1993 (figure 6b). The test, minus the anteriorly directed force on the humeral head, became known as the apprehension test (figure 6a).

5.2 Relocation Test

Jobe et al.[44] described the relocation test in 1989. This test should be performed immediately after the apprehension or augmentation tests, when the patient is still in the position of apprehension. The examiner should apply a posteriorly directed force to the humeral head, relocating it on the glenoid. In a positive test the patient's apprehension was reduced by this manoeuvre (figure 6c). This test was validated by Speer et al.[39] in 1994, who used the augmentation test as the initial manoeuvre. These investigators found the test to

Fig. 7. Posterior apprehension test.[55] The arm is positioned in 90° flexion and fully internally rotated. A positive test produces pain that is relieved by a glenohumeral injection of local anaesthetic.

have a sensitivity of 57(**(Author: 50% appears in tbl 1. Please clarify)**)% and a specificity of 100%. However, to ensure consistency of technique between examiners, the examiners performed the test in 90° abduction and external rotation, not full external rotation.

5.3 Release Test

Silliman and Hawkins[45] described the release test in 1993 in the same article that renamed the original apprehension test. This test should be performed immediately after a positive relocation test by suddenly removing the posteriorly directed force that is relocating the humeral head (figure 6d). A positive test occurs when the patient's symptoms are increased by this manoeuvre. This test was validated by Gross[46] in 1997. He found it to have a sensitivity of 92% and a specificity of 89% (table I).

The validations for all these tests have been performed using patients whose unstable shoulder required surgical repair. Patients whose shoulder's subluxate (especially overhead athletes) are much harder to diagnose. Many authors[12,43,45,47-50] have stated that patients will get pain during these provocative tests (especially the relocation and release tests) and that this should be considered as a positive test. Others[14,51-54] have stated that only patients whose shoulder instability has developed via overuse will get pain, while those whose instability is the result of trauma will become apprehensive.

We assessed the inter-examiner reliability of these tests in 1999[28,36] and found that all of the provocative tests of anterior instability were more reliable when apprehension alone was considered a positive test. The apprehension test had an intraclass correlation coefficient (rho score**((Author: please spell out 'rho'))**) of 0.47. The relocation test had a rho score of 0.71, the release test a rho score of 0.63 and the augmentation test had a rho score of 0.48 (table II).

O'Driscoll[55] described a posterior apprehension test in 1991 in which the arm was positioned in 90° flexion and fully internally rotated (the same position as that of Hawkins and Kennedy's[56] impingement test) [figure 7]. Injections of local anaesthetic were then made into the subacromial space and the glenohumeral joint.

5.4 Superior Labral Lesions

While detachment of the superior labrum (SLAP**((Author: please define 'SLAP'))** lesion) rarely causes frank instability, the lesion sometimes occurs in association with an anterior labral**((Author: …labral lesion?))** (Bankart lesion), and occurs in a similar age group,[57] often in overhead athletes. O'Brien et al.[58] described a test where the patient is asked to resist the examiner while their arm is in 90° forward flexion, 10° adduction and the thumb pointing down (figure 8). A positive test is when pain is elicited and that pain is reduced when retested with the patient's palm facing upwards. The test has moderate to very good clinical usefulness [likelihood ratio (LR): 3 to 50, **table III**]. Liu et al.[59] described the 'crank' test, performed with the arm elevated to 160° in the scapular plane of the body, loaded axially along the humerus, and with maximal internal and external rotation,[59] with good clinical usefulness (LR: 13, table III).

6. Conclusion

Many of the tests of shoulder instability are yet to be assessed as to their clinical utility.[61] Of the laxity examinations, the load and shift test in the 90° abducted position is the only test that has been validated that assesses anterior and posterior laxity (figure 1). In the posterior direction, the test has been found to be more reliable when performed in the 0° abducted position with the patient seated.[28,36] In the inferior direction, the sulcus sign (figure 4) has been found to be more sensitive and equally as specific as the load and shift test in this direction.[28,36] The sulcus sign also indicates the possible presence of multidirectional instability.[28,36,41] The provocative tests for instability (apprehension, augmentation, relocation and release tests) [figure 6] have all been found to be most reliable when apprehension alone is considered as a positive test.[28,36]

In summary, the stability examination should be performed as part of a complete shoulder examination.[62-64] Based on the available data, the suggested shoulder examination for a patient with a history suspicious for instability begins with the patient seated. One should determine the size of the sulcus sign (figure 4) present, perform the

Fig. 8. O'Brien's test.[58] A test for superior labral detachment (SLAP **((Author: superior labrum?))** lesion). (**a**) The patient is asked to resist the examiner while holding the arm in the illustrated position (90° forward flexion, 10° adduction and the thumb pointing down). (**b**) A positive test is when pain is elicited and that pain is reduced when retested with the patient's palm facing upwards.

Author proof

Table III. Validity of clinical tests for superior labral (SLAP) lesions

Test	Sensitivity (%)	Specificity (%)	Likelihood ratio (+)	Likelihood ratio (–)	Reference
O'Brien's test	100	98	50	0.0	58
	88	68	3	0.2	60
Crank test	91	93	13	0.1	59

O'Brien's sign (figure 8) for superior labral lesions, then perform the load and shift test in the posterior direction with the arm at 0° abduction. Then the investigator should place the patient in the supine position. The load and shift test should be performed with the arm at 90° abduction in the anterior and posterior directions (figure 1). Finally, one should perform the apprehension (figure 6a), augmentation (figure 6b), relocation (figure 6c) and then release tests (figure 6d) focusing on apprehension rather than pain.

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