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"Important Details in Performing and Interpreting the Scratch Collapse Test"

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Short Running Head: Nuances of the Scratch Collapse Test

This manuscript is written in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000. A HIPAA media release agreement was signed by each patient prior to the recording of each video.

Abstract

The utility of the Scratch Collapse Test (SCT) has been demonstrated in examination of patients with carpal and cubital tunnel syndromes and long thoracic and peroneal nerve compressions. In our clinic, this lesser known test plays a key role in peripheral nerve examination where localization of the nerve irritation or injury is not fully understood. Test utility and accuracy in patients with more challenging presentations likely correlates with tester understanding and experience. This paper offers a clear outline of all stages of the test in order to improve inter-rater reliability. The nuances of test performance are described, including a description of situations where the SCT is deemed inappropriate. Four clinical scenarios where SCT may be useful are included. Corresponding video content is provided to improve performance and interpretation of SCT.

Introduction:

The evaluation of patients with peripheral nerve disturbance or injury typically involves an array of clinical tests. Electrodiagnostics, provocative tests, Tinel and strong subjective history are commonly used and typically successful in developing an adequate treatment plan for the patient[1-3]. There are instances, however, where in spite of an exhaustive examination the diagnosis remains elusive or unclear. In these situations in our clinic the sensory stimulus test known as the "Scratch-Collapse" Test (SCT) has demonstrated its utility. To date in the literature we have purposely introduced the SCT in patient populations where a clear diagnostic "gold standard" exists in order to encourage the use and comparison of the test with common, well studied diagnoses[4-6]. We submit that with adequate instruction and practice, any interested clinician can incorporate this test into all peripheral nerve evaluations. The purpose of this paper is to give a comprehensive description of the test performance.

The SCT has been described in the literature and demonstrated to be useful in the evaluation of carpal, cubital and peroneal nerve compressions[4-6]. In each of these sensitivity, specificity, as well as both positive and negative predictive values were demonstrated to be similar to, if not better than, the Tinel sign. In addition, its utility has been demonstrated in the evaluation of long thoracic nerve palsy[7] (Table 1).

In spite of its demonstrated clinical usefulness there remains no comprehensive explanation as to how the SCT works. A positive response to this test involves a momentary loss of volitional power in a specific muscle group in the upper extremity. Similarities have been drawn to the Cutaneous Silent Period (CSP). The CSP refers to the upper extremity withdrawal response to a noxious stimulus. It is believed that this is an inhibitory spinal reflex mediated by

A delta fibers and has been demonstrated by EMG to inhibit movement in response to painful stimuli in the fingertips and thumb[8,9].

The stimuli used with the SCT would not be considered a noxious stimulus to normal tissue however when introduced to an area of nerve irritation an allodynic response is noted. It has been surmised that this correlates to the prevalence of Substance P in the injured area.

Substance P, a neurotransmitter, is well described in the literature as a modulator of nociception which is involved in the signaling of noxious stimuli[10]. Elevated levels of Substance P has been documented in the carpal tunnel where intra-operative tissue samples taken from patients undergoing carpal tunnel release revealed changes in Substance P levels in neuronal and non- neuronal tissues[11]. In addition, following nerve injury or in chronic inflammatory conditions, increased substance P may be observed in central and peripheral sensory nerve endings[11-14]. This correlation between the presence of Substance P and nerve injury aids in the understanding of the reflexive collapse response noted in the SCT.

Test Procedure:

The SCT does not require equipment, money or excessive time. To fully master it however, requires a strong knowledge of surface anatomy and a willingness to practice. We recommend initially testing patients with a clear diagnosis and gradually incorporate it to the evaluation of more complicated patients as competency and accuracy improve.

The following is a step by step description of the SCT. There are video clips available for viewing that will reiterate each phase of the test procedure.

Positioning:

The test is typically performed in a seated position however may be performed in stance or supine. When performed in sitting the patient should sit forward so as not to be resting against

the back of the chair. The arms should be in line with the body, fully adducted at their sides with the elbows flexed to 90 degrees and the forearms and wrists in the (thumbs up) neutral position. The tester should be positioned directly facing the patient, seated if the patient is seated and in stance if the patient is standing (See Video 1, Supplemental Digital Content 1, which illustrates the correct positioning of patients in sitting, standing or supine when performing the Scratch Collapse test, INSERT HYPER LINK) (Video Graphic 1).

Set-up:

A brief outline of the test procedure is described to the patient to enable full cooperation and understanding. The patient must understand that this is not a test of greatest strength effort, therefore they should not be giving maximum resistance in response to pressure applied by the tester. Spending a few moments to demonstrate the amount of resistance required to create "a balance" with the tester is helpful. (This may be demonstrated by having the examiner and patient practice exerting pressure palm to palm to understand the "balance point" of equal opposing pressure.) Once this balance is established the patient is instructed to remain in the test position while the tester removes his/her hands to proceed with the stimulus phase of the test.

This allows the examiner to quickly return to the resistance phase of the test without repositioning the patient. The response to the "scratch" is rapid and may fade if too much time lapses between the swipe and the pressure (See Video 2, Supplemental Digital Content 2, which demonstrates the way in which test is described to the patients and the concept of 'balance' is demonstrated in preparation for the test performance, INSERT HYPER LINK) (Video Graphic 2).

Pre-test:

Pressure is applied by the tester to the dorsal aspect of bilateral forearms (not the hands/wrists) so as to encourage a resistance response from the patient in the direction of shoulder external rotation. At this time, the patient must demonstrate two things: 1) that they understand how to balance the amount of pressure applied by the tester so no extraneous movement occurs, and 2) that the movement they perform is purely external rotation without substitution movements, such as shoulder abduction. A common testing error occurs when the examiner allows the patient to resist applied pressure with the deltoid muscles, raising the elbows away from the sides (See Video 3, Supplemental Digital Content 3, which demonstrates the application of the irritant during the scratch collapse test, INSERT HYPER LINK) (Video Graphic 3).

Irritant:

The test name gives a false impression of the type of irritant that should be applied to the patient. The four most common irritants used in the SCT are touch/swipe of a finger, scratch, blown air and deep pressure. A sensory stimulus of some type is needed to create a response in the specific area of nerve irritation/injury. Allodynia is pain developed in response to stimuli which would not cause pain in normal tissue[15]. Blown air is an example of such a stimulus. A more profound response may be elicited from blowing on the suspected area of injury than from a finger swipe/light touch. In situations where there is a high level of Allodynia a simple fanning of the area with the tester's hand to create air movement may be adequate to elicit a positive response. In regions where there is more soft tissue over the suspected site of compression or injury deeper pressure rather than a light touch may be required to elicit a response. This is often the case with proximal median nerve compression in the forearms and saphenous nerve compression in the thighs of large or obese patients (See Video 4,

Supplemental Digital Content 4, which illustrates the utility of the test for precise localization of a nerve insult or irritation, INSERT HYPER LINK) (Video Graphic 4).

Establish a negative control:

Once the set up and explanation are complete the irritant is applied to an uninvolved area to establish a negative control. The uninvolved limb or an area that has no potential nerve compression may be used for this control. This gives the examiner the opportunity to practice and assess the patient's ability to follow direction prior to touching a suspected site of injury. Given that the patient is unaware of the expected response it is difficult to falsify the test response. However, if all pre-tests result in collapse one may suspect non-compliance or malingering.

Test Results:

Once the irritant is applied, pressure is immediately applied to bilateral forearms in the direction of shoulder internal rotation. If the patient is able to maintain equal pressure and balance the force applied by the tester the test is deemed negative. If the ipsilateral arm collapses inward towards the chest the test is positive. The amount of collapse can vary with the test site as well as from person to person. Any momentary loss of force in response to an irritant is deemed positive. In some cases the response is very clear with total loss of power. When several areas of a limb elicit a response there is typically one area which collapses with greater ease than others and this is interpreted as the area of greatest nerve injury or irritation. The test may repeated without a rest period (See Video 5, Supplemental Digital Content 5, which demonstrates the Scratch Collapse test performed on a patient with multi-level nerve compression.

Establishing a hierarchy of nerve irritability is demonstrated with use of ethyl chloride spray, INSERT HYPER LINK) (Video Graphic 5).

Hierarchy:

The concept of double crush was first introduced in 1973 by Upton and McComas[16]. It is now generally understood that constraints to axoplasmic flow from a proximal nerve compression or lesion can make the distal nerve more prone to compression[17]. In addition, patients who have sustained traumatic injuries may have an edematous limb from the trauma, surgery or from prolonged disuse that can increase the potential for restriction at the existing entrapment points[18]. Patients with a proximal nerve compressions therefore may elicit positive provocative signs at distal compression points. When evaluating a patient with paresthesia and/or nerve pain one should evaluate then nerve along the entire limb to rule out these potential proximal or distal compressions.

If we consider that Substance P is predicted to exist in greater concentrations in areas of the greatest amount of injury we would assume when performing the SCT that the strongest or "primary" nerve irritation should correlate with the easiest or only positive collapse .

Once this is established one can temporarily mask that response with ethyl chloride spray. This freezing agent has been shown to block the positive response of SCT[19]. It is surmised that the cold spray blocks the Substance P to give a False negative. At this time we are uncertain of the exact length of time the area sprayed with ethyl chloride will produce a false negative response. Within a single clinic visit this area is typically not retested once it has been sprayed and demonstrated the corresponding false negative response.

Once the spray is applied and the false negative response is confirmed one can move to a second area where nerve irritation is suspected. This does not need to be along the same nerve or even the same side of the body. If, for instance, a patient

complains of right cubital tunnel symptoms and left carpal tunnel symptoms they may initially only collapse at the right medial elbow. However, once the ethyl chloride spray is applied to medial elbow a retest may reveal a positive response in the left volar wrist. At that point you would interpret the response as primary irritation / injury at the right cubital tunnel and secondary at the left carpal tunnel. One could continue in this manner with further testing for additional levels.

This is very useful in situations where the expected response is not elicited. For example, if the clinical examination clearly suggests CTS but there is no positive SCT result, an assessment of the proximal compression points should be performed. Frequently the site of compression of the median nerve at the pronator teres or the cervical spine will elicit a greater response suggesting a problem in those areas as well.

When no compression points are positive but the remaining clinical exam suggests there is a problem with a specific site you may need to look further into the patient's medical history. A pre-existing nerve injury in an unrelated body part may be left out of the health history if the patient deems it unrelated to the reason for their visit. Testing the "unrelated" site will help to rule it out as the "primary" nerve irritation point. If positive, this can be "frozen out" and the test repeated to the suspected area of complaint. This scenario illustrates the utility of an extensive pain evaluation during the subjective exam to establish the scope of the patient's pain.

The body pain scale is useful as a prompt to include all areas of pain by asking patients mark those on the image. Instructions should be clear to include all areas whether or not they are pertinent to the reason for their visit. Establishing a hierarchy of nerve irritation will aid in defining your clinical management[18].

Situations when the SCT is deemed inappropriate:

There are situations where the SCT should not be attempted. The performance of the test relies on a structurally and neurologically intact posterior rotator cuff. Any preexisting weakness may skew the result. Therefore, one should avoid using this test with patients who have rotator cuff insufficiency and those with upper trunk plexopathies. In addition, patients with poor cognitive function should not be tested. The test relies on the ability of the person being tested to follow instructions. Performance of the test on patients with limited cognitive skills may result in false positive or false negative results. It has also been noted by users of this test in our clinic setting that patients who have a difficult time giving less than maximum effort (just enough to create "balance") will yield a skewed test result.

Case situations:

The SCT is not a necessary tool for the straight forward case where traditional clinical signs, both objective end subjective, lead to a definable diagnosis. Similarly there are cases where the signs and symptoms are clear and electrodiagnostic studies are not needed to make a diagnosis. The American Association of Electrodiagnostic Medicine has stated in a consensus study that the "gold standard" for the diagnosis of Carpal Tunnel Syndrome is clinical testing, not electro-diagnostic testing[20]. Usefulness of SCT can be unmatched in situations where testing is inconclusive and questions remain regarding the specific source of the complaint/symptom.

Clinical scenarios when the SCT may be useful:

Four scenarios are presented to illustrate the utility of the Scratch-Collapse test

1. atypical presentation of symptoms
2. continued or exacerbation of symptoms following a nerve release
3. query a double crush

4. non-specific localization of symptoms.

1. ATYPICAL PRESENTATION OF SYMPTOMS:

A woman in her 60's presented with a 3 year history of left knee pain. Review of surgeries performed to address this pain included arthroscopy, partial knee arthroplasty and a total knee arthroplasty. The pain was localized to the medial - inferior knee. Subjective history of the pain revealed some medial thigh pain at the onset and a history of a twisting fall preceding that. The patient had palpable tenderness deep in the medial thigh. As all boney involvement had been ruled out, nerve compression was queried. SCT performed with deep palpation (verses a swipe) to the medial thigh was strongly positive. Following a saphenous nerve release in the medial thigh all the patient's original pain resolved.

2. EXACERBATION OF SYMPTOMS FOLLOWING NERVE RELEASE:

A 72 year old man presented in the clinic with severe neuropathic pain, increased paresthesia in the thumb and index finger and complete loss of thenar strength 6 weeks following a carpal tunnel release. A SCT performed to the scar was negative however just proximal to it at the volar wrist crease there was a strong response. An incomplete release (axonometic) or iatrogenic (neurotometic) injury was suspected and the patient was scheduled for an exploration of the carpal tunnel. (See Video 6, Supplemental Digital Content 6, which demonstrates the test performed on the patient described in case 2: "exacerbation of symptoms following nerve release". The test is used to localize the suspected area of injury or compression following a carpal tunnel release. (Subsequent exploratory surgery was performed during which the median nerve was released in the distal forearm and the motor branch neurolysed. The symptoms resolved and the patient returned to work), INSERT HYPER LINK) (Video Graphic 6).

Following surgery that included exploration, rerelease of the carpal tunnel and neurolysis of the deep motor branch of the median nerve the patient had complete resolution of pain and recovery of thenar muscle function.

3. QUERY A DOUBLE CRUSH

This patient presented to our office 5 months following a carpal tunnel release with continued paresthesias in the median distribution of the R hand and painful ache in the forearm and wrist. Conservative post-operative management was exhausted unsuccessfully. Tinel was absent at the carpal tunnel however the patient did provoke to deep palpation at the proximal volar forearm. SCT was negative at the carpal tunnel but positive at the proximal compression point of the median nerve at the pronator teres. A double crush of the median nerve was suspected and the nerve was released at the pronator. Pain in the forearm resolved and patient reported resolution of paresthesia.

4. NON-SPECIFIC LOCALIZATION OF SYMPTOMS

A 34 year old surgical resident presented with occasional nocturnal paresthesia in the hands and pain in the forearm. Sensation was intact in the radial sensory distribution of the hand. He was tender to palpation at the radial tunnel. A SCT was negative at the carpal, cubital and radial tunnels. Given the dermatomal presentation of paresthesia in the hand a SCT was performed at the L lower cervical region and found to be positive. This patient was referred to PT for conservative management of potential cervical radiculopathy.

Discussion:

The key components of a comprehensive peripheral nerve exam remain subjective history,

sensory/motor testing, provocative testing and electro-diagnostics. Diagnoses may easily be made with these longstanding reliable and sensitive tests. There are situations, however, where questions remain or the source of the problem is not fully elucidated. The sensory stimulus test known as the SCT is a lesser known test that may play a key role in such situations.

Sensitivity, specificity, positive and negative predictive values have all been shown to be equal to if not greater in the SCT than the Tinel sign in carpal tunnel syndrome, cubital tunnel syndrome and peroneal nerve compressions (Table 1). These values have been disputed in the literature[21]. We postulate that test utility and accuracy correlate with tester experience.

Unlike other provocative tests the SCT contains multiple steps and relies on the tester's experience and knowledge of the subtitles of the test to perform it accurately.

There are those who question the neutrality of the SCT tester and believe the tester may alter their technique to force a positive response. In addition, there are those who believe that the patient may attempt to alter the outcome of the test. To improve confidence in the test we have recently found that test results can be replicated with the patient's vision occluded and using a wave of the hand for air current as stimulus that is not easily detectable in the suspected region of nerve injury. The following video demonstrates this technique. (See Video, Supplemental Digital Content 7, which demonstrates how the patient's vision occluded to limit his knowledge of the test technique including the timing and placement of the stimulus. In addition, a wave of the hand to create air current in the suspected region of nerve injury is used as a stimulus that is not easily detectable but is adequate for a positive response in areas of significant nerve disturbance, INSERT HYPER LINK) (Video Graphic 7).

While test performance does not necessitate excessive time, equipment, or assistance to fully master the Scratch Collapse Test a strong knowledge of surface and nerve anatomy as well as a willingness to practice is required. We recommend using the test initially on patients with a clear diagnoses supported by standard measures and gradually introducing it into the examinations of more complicated patients. The descriptions and videos outlined here are designed to improve tester understanding and test performance so as to ultimately improve inter- rater reliability.

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	sensitivity of TINEL	sensitivity of SCT	specificity of TINEL	Specificity of SCT	negative predictive value TINEL	negative predictive value SCT	positive predictive value TINEL	positive predictive value SCT
Carpal tunnel syndrome	32%	64%	99%	99%	59%	74%	96%	99%
cubital tunnel syndrome	54%	69%	99%	99%	98%	86%	97%	99%
peroneal nerve compression	65%	77%	99%	99%	88%	92%	94%	95%