OPEN

PRS GLOBAL OPEN

ORIGINAL ARTICLE
Peripheral Nerve

Updates to the Physiologic Mechanism, Anatomical Sites, and Diagnostic Utility of the Scratch Collapse Test: A Systematic Review

Alicia M Faszholz, MS2*
Jonathan Cheng, MD†

Background: The scratch collapse test (SCT) has gained popularity as a physical examination technique for diagnosing compression neuropathy. This systematic review aims to assess the reliability of the SCT as a diagnostic tool for compression neuropathy, as well as to propose the underlying physiological mechanisms involved. Specific criteria was developed to broaden the potential anatomical applications of the SCT.

Methods: A literature search was conducted using PubMed, Embase, Scopus, and Google Scholar. Eleven articles meeting predefined inclusion/exclusion criteria were selected for numerical analysis, which yielded sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy values.

Results: In total, 890 patients with carpal tunnel syndrome were reported in 10 studies. The mean (±SD) sensitivity, specificity, PPV, NPV, and accuracy were 0.442 ± 0.272, 0.788 ± 0.163, 0.834 ± 0.143, 0.433 ± 0.297, and 48.8% (range, 31%–82%), respectively. Of the studies that provided interrater reliability (κ), the mean was 0.544 ± 0.441, indicating moderate agreement. A total of 121 patients with cubital tunnel syndrome were reported in three studies, with a mean (±SD) sensitivity and specificity of 0.635 ± 0.367 and 0.945 ± 0.06, respectively. Twenty-four patients with peroneal nerve compression, reported in one study, had sensitivity, specificity, PPV, NPV, and accuracy of 0.77, 0.99, 0.95, 0.92, and 93%, respectively.

Conclusions: Current literature indicates that the SCT can serve as a provocative test to assist in diagnosing compression neuropathy. Nevertheless, the heterogeneity of reported values underscores the necessity for further investigation aimed at enhancing the objectivity of SCT, thus improving interrater reliability and minimizing potential bias. *(Plast Reconstr Surg Glob Open 2024; 12:e5998; doi: 10.1097/GOX.0000000000005998; Published online 19 July 2024.)*

INTRODUCTION

Compression neuropathies are common syndromes that occur from direct injury, compression, or stretch of a nerve, with carpal tunnel syndrome (CTS) being the most prevalent. Compression neuropathies may result in altered sensation, pain, and muscle weakness or atrophy along the distribution of the affected nerve.[1] There is currently no gold standard for diagnosing compression neuropathies.[2–4] Depending on the location of suspected nerve entrapment, a diagnosis is obtained with multiple physical exam maneuvers (eg, Tinel sign, Durkan test, and Phalen test), in combination with an electrodiagnostic test and a strong patient history.[3] Additional complexity is posed to the diagnosis of compression neuropathy given that each clinical test has a variable range of reported sensitivity and specificity. Therefore, a combination of provocative tests from a physician's diagnostic repertoire is required to confirm a diagnosis.[5]

The scratch collapse test (SCT) is an increasingly popular clinical test that has demonstrated the potential to detect compression neuropathy of the median, ulnar, and

*From the *TCU Anne Burnett Marion School of Medicine, Fort Worth, Tex.; and †Department of Plastic Surgery, University of Texas Southwestern Medical Center, Dallas, Tex.*

Received for publication February 22, 2024; accepted May 9, 2024.

DOI: 10.1097/GOX.0000000000005998

Disclosure statements are at the end of this article, following the correspondence information.

Related Digital Media are available in the full-text version of the article on www.PRSGlobalOpen.com.

peroneal nerves.[6] Furthermore, the utility of the SCT is being expanded to include additional locations of nerve compression, as illustrated in the recent literature (Fig. 1). The SCT can also localize multiple levels of nerve compression along a single nerve tract. Of note, a recent study has shown the application of the SCT in localizing sites of secondary nerve compression after temporarily freezing the primary site with a topical anesthetic.[29]

Proper technique of the SCT is performed with the patient seated in a neutral position with both feet on the ground, arms at the sides, and elbows held at 90 degrees flexion. The examiner applies a steady internal rotation force to the patient's dorsal forearms (*not* wrists or hands) while the patient attempts to externally rotate against the examiner, achieving a balance in resistance. While the patient remains in the neutral position, the examiner releases both forearms to "scratch" the surface of the skin along the tract of the possible compressed nerve, followed by immediate repetition of the above resisted force. If nerve compression is present, there will be a momentary loss of resistance in the external rotation of the ipsilateral arm, which is judged to be a "collapse," or "positive" SCT test result.[3] [**See Video (online),** which demonstrates the methodology of the SCT on a patient with common peroneal neuropathy. From Gillenwater J, Cheng J, Mackinnon S, Evaluation of the scratch collapse test in peroneal nerve compression. *Plast Reconstr Surg.* 2011;128:4:933-939. © 2011 American Society of Plastic Surgeons. Used with permission of Wolters Kluwer Health.] The examiner must be well-versed in surface anatomy pertaining to the underlying nerve of interest to perform the SCT correctly and accurately.[6]

The purpose of this study was to provide a comprehensive overview of all current information regarding the SCT, to analyze the reliability of the SCT, and to identify potential modifications to improve the utility of the SCT as a diagnostic tool for compression neuropathy.

Takeaways

Question: What is the utility and reliability of the scratch collapse test (SCT) as a diagnostic tool for compression neuropathy?

Findings: There is significant heterogeneity in the recorded sensitivity, specificity, positive predictive value, negative predictive value, and accuracy values across all included studies. The underlying physiologic mechanism is reviewed, and specific criteria were developed to expand potential anatomical locations for use.

Meaning: The SCT is an emerging provocative test useful in diagnosing compression neuropathies. The heterogeneity underscores the need for further investigation to enhance the objectivity of SCT evaluation to improve interrater reliability and minimize potential bias, thereby improving its clinical utility and acceptance.

METHODS

A systematic review was conducted according to the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) reporting guidelines[30] (Fig. 2). A set of inclusion and exclusion criteria was established before the search.

Literature Search

Literature searches were conducted initially using the PubMed database: A broader search was conducted, and no derivations of the name "scratch collapse test" were found; therefore, the search was limited to studies, including the name as written. Additional literature searches of Embase, Scopus, and Google Scholar databases were conducted in an identical manner. Additional search of Web of Science, Cochrane review, and HaPI yielded no additional results, based on predetermined inclusion and exclusion criteria.

We included all full-text articles that evaluated the use of the SCT in diagnosing compression neuropathy and were published between January 1983 until January 2024. Electrodiagnostic studies were used as the reference standard for the diagnosis. Articles were excluded if they did not report outcomes from analysis of unique primary data and were written in languages other than English or Spanish. We also excluded case reports, letters/editorials/discussions and articles that utilize the SCT purely as inclusion/exclusion criteria for their own study.

Data Abstraction and Analysis

First, the title and abstract of each citation were reviewed and many articles were thus removed for having incorrect subject matter or by utilizing our exclusion criteria detailed above. All remaining full-text articles were reviewed in-depth for inclusion by both authors. Specific data was reviewed and abstracted for all pertinent articles including number of patients in a study, location of nerve entrapment, numerical data, and descriptive results. Studies that provided numerical data were analyzed by measures including sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), accuracy, and interrater reliability (κ). Any difficulties with data abstraction were resolved through discussion and thorough evaluation with both authors.

RESULTS

The initial search of PubMed yielded 67 results, of which 35 were immediately excluded due to incorrect or irrelevant topics. Of the remaining 32 articles, five were excluded as they did not deal directly with the SCT. Eighteen articles, including reviews, case reports, editorials, descriptions, and qualitative studies, were excluded because they did not provide unique numerical data. Of the nine remaining studies that met our inclusion criteria, one study was excluded based on an included figure that appears to be testing internal rotation instead of external rotation as required for the SCT. Additional searches of Embase, Scopus, and Google Scholar were conducted in an identical manner, and each yielded one additional article with unique numerical data for analysis. We identified 11 studies that met our inclusion criteria. All studies contained either level II or III evidence, based on the ASPS evidence rating scale.[31,32]

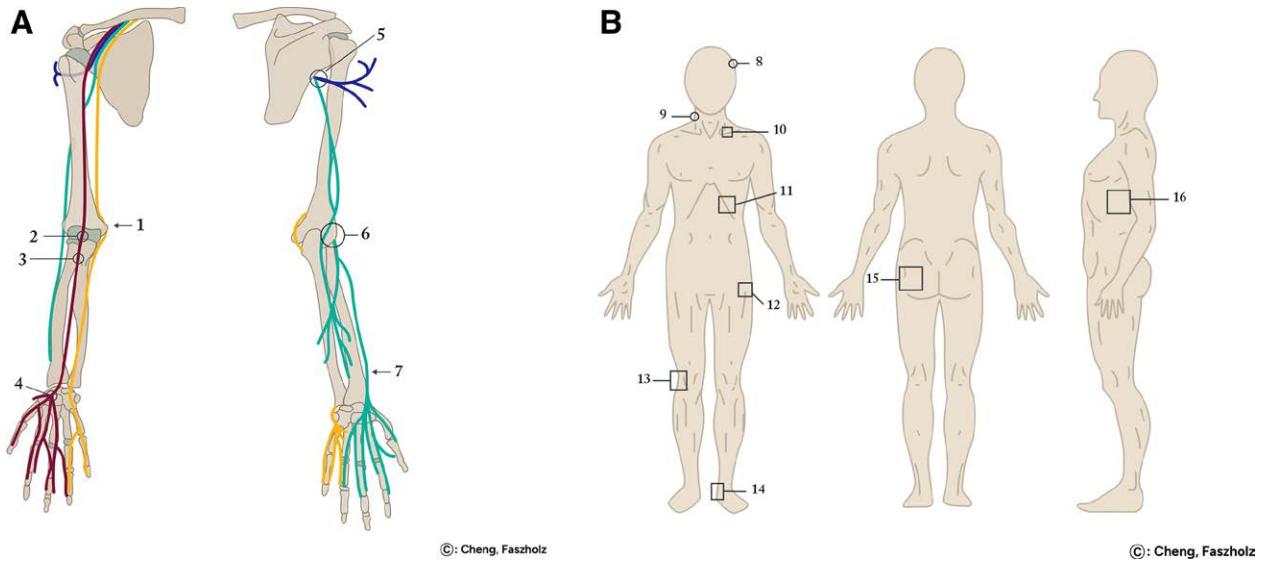

Fig. 1. Anatomical locations of use of the Scratch Collapse Test. A, Diagram demonstrating the anatomical locations of use of the SCT as found in the current literature; key provided. B, A diagram that demonstrates the anatomical locations of use of the SCT as found in current literature; key provided. Key for Figure 1A: 1. Cubital tunnel syndrome[3,7–9]; 2. Pronator syndrome/proximal median nerve entrapment[10,11]; 3. Lacertus syndrome[12]; 4. CTS[3,7–9,13–18]; 5. Quadrangular space syndrome/axillary nerve entrapment[19,20]; 6. Radial tunnel syndrome[19]; 7. Wartenburg syndrome[19]. Key for Figure 1B: 8. Trigger sites for migraine surgery[21]; 9. Cervical radiculopathy[22]; 10. Thoracic outlet syndrome[23]; 11. Anterior cutaneous nerve entrapment syndrome[24]; 12. Meralgia paresthetica/lateral femoral cutaneous nerve[25]; 13. Common peroneal nerve compression[6]; 14. Tarsal tunnel syndrome[26]; 15. Piriformis syndrome[27]; 16. Long thoracic nerve palsy.[28]

In assessing the utility of the SCT, 890 patients with CTS were evaluated across 10 studies. The mean (±SD) sensitivity was 0.442 ± 0.272. The mean (±SD) specificity was 0.788 ± 0.163. The mean (±SD) PPV and NPV was 0.834 ± 0.143 and 0.433 ± 0.297, respectively. The overall accuracy was 48.8% (range, 31%–82%). Of the studies that provided interrater reliability (κ), the mean was 0.544 ± 0.441 with a range of −0.025 to 0.98 (Table 1).[3,7–9,13–18]

In the three studies investigating the utility of the SCT in cubital tunnel syndrome, a total of 121 patients were evaluated. The mean (±SD) sensitivity was 0.635 ± 0.367. The mean (±SD) specificity was 0.945 ± 0.06. PPV, NPV, and accuracy values were only provided by Cheng et al,[3] revealing a PPV of 0.99, NPV of 0.86, and accuracy of 89%. Interrater reliability values (κ) were not provided (Table 2).[29,33]

Of the studies that evaluated the utility of the SCT for peroneal nerve compression, only Gillenwater et al,[6] provided numerical data. They evaluated 24 patients with peroneal nerve compression, and the sensitivity, specificity, PPV, and NPV values were 0.77, 0.99, 0.95, and 0.92, respectively. The accuracy was 93%, and interrater reliability value (κ) was not provided (Table 3).

Our review of the literature revealed only two incomplete mechanistic proposals: the cutaneous silent period (CSP), and the increased concentration of substance P (SP) at sites of nerve compression. The lack of experimental study of these potential mechanisms precluded the use of the PRISMA methodology.

DISCUSSION

The SCT is still novel in its use for diagnosing compression neuropathy; however, the SCT faces criticism, given its history of variable reliability and accuracy in published reports.[5,34–36] This review seeks to evaluate the diagnostic utility and applicability of the SCT by assessing the current literature and providing an updated report regarding its clinical utility, physiologic mechanism, and anatomic locations for use.

Although there is currently no agreed-upon physiologic mechanism to explain the SCT, there are two incomplete mechanistic proposals described in the literature.[3,37,38] The first mechanistic proposal is of the CSP, a period of relative or absolute electrical silence and inhibited tonic voluntary muscle activity following a noxious or harmful peripheral stimulus to the selected nerve tract.[38,39] When performing the SCT, the brief reduction in force seen with the "scratch" of the compressed nerve could be secondary to decreased function of motor nerve fibers following axonal damage or impaired nerve conduction.[13,38,39] Worsening degrees of peripheral nerve compression, particularly in CTS, are accompanied by increased latency of the CSP, demonstrating possible overlap of CSP and SCT mechanisms.[38]

The hypothesis of SP, a neurotransmitter commonly involved in nociception, was first described in the literature by Ozturk et al in relation to CTS, but was then applied to the SCT by Davidge et al, as a rationalization for why one can "freeze out" secondary sites of nerve compression with topical sprays/anesthetics.[29,40] This finding was adapted as a mechanism to explain the SCT, using the hypothesis that noxious stimulation from "scratching" near the surface of the compressed nerve could incite localized SP release and thus trigger an undefined inhibitory response.[29,40] This involvement of SP appears less likely when we compare the duration of SP's half-life,

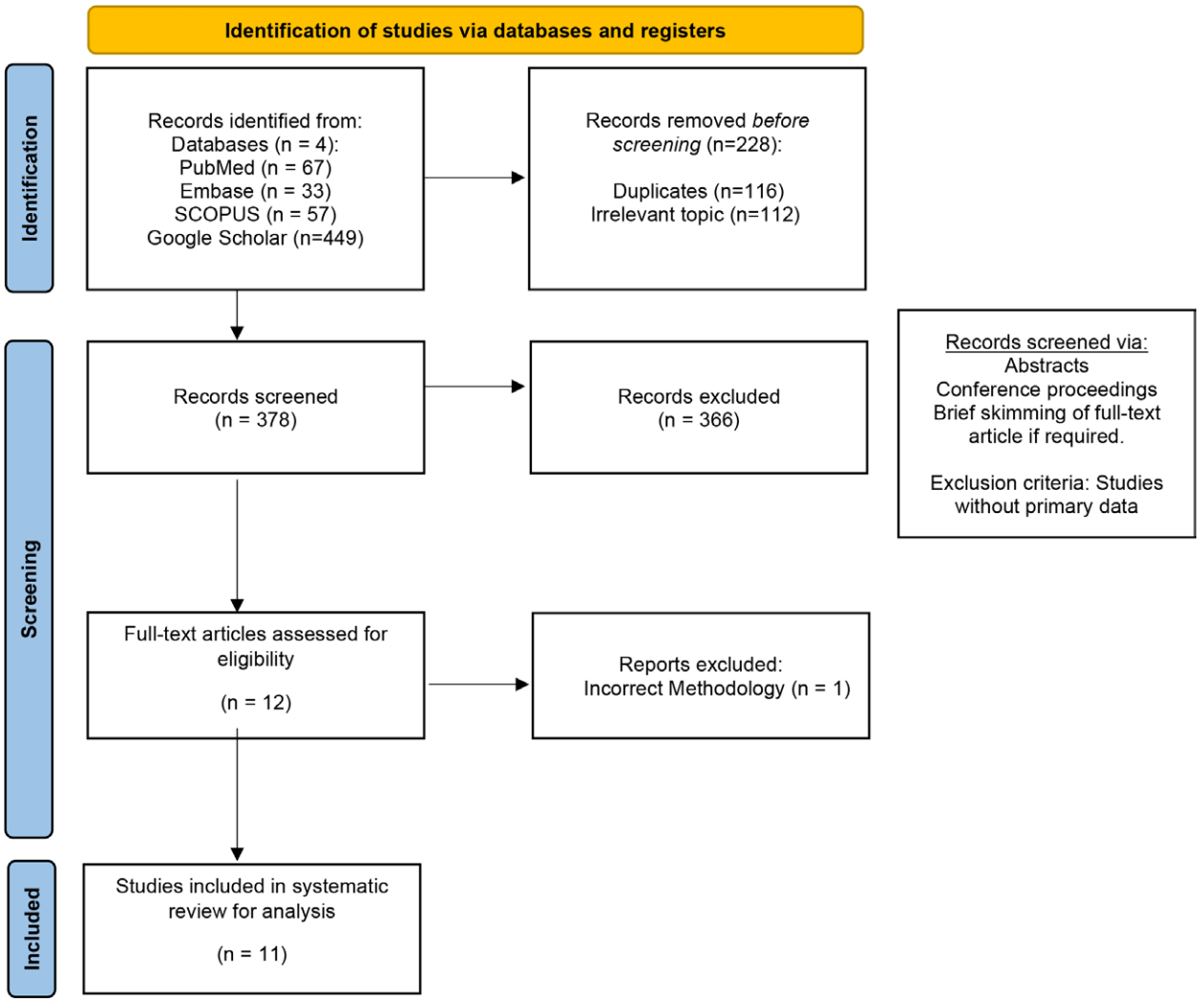

Fig. 2. Photograph showing the PRISMA diagram of the systematic review.

Table 1. Numeric Data of the Analyzed Studies in Terms of Sensitivity, Specificity, PPV, NPV, Accuracy, and Interrater Reliability, Carpal Tunnel Syndrome

Article	Nerve of Interest	No. Patients	Sensitivity	Specificity	PPV	NPV	Accuracy	Interrater Reliability [as Measured by (K)]
Cheng et al[3]	Median nerve/CTS	119	0.64	0.99	0.99	0.73	82%	0.98
Blok et al[7]	Median nerve/CTS	37	0.32	*	*	*	*	0.63
Makanji et al[14]	Median nerve/CTS	88	0.31	0.61	0.71	0.25	41%	*
Simon et al[15]	Median nerve/CTS	40	0.24 (blinded) 0.28 (unblinded)	0.6 0.75	0.73 0.81	0.15 0.2	31% 37%	0.925
Montgomery et al[8]	Median nerve/CTS	91	0.7 0.15 (CTS-6 criteria)	0.78 0.87 (CTS-6 criteria)	*	*	*	-0.025 (resident/technician 1) 0.211 (resident/technician 2)
Areson et al[13]	Median nerve/CTS	40	0.48	0.59	0.61	0.45	48%	*
Bahadir and Bahadir[18]	Median nerve/CTS	110	0.17	0.97	0.95	0.23	*	*
Cao et al[17]	Median nerve/CTS	236	0.68	0.72	0.87	0.45	*	Single evaluator
Pisquiy et al[9]	Median nerve/CTS	51	0.88 (SCT on upper) 0.82 (SCT on lower)	*	*	*	*	*
Mazhar et al[16]	Median nerve/CTS	78	0.08	1	1	1	53.80%	Single evaluator

*Information not provided.

Table 2. Numeric Data of the Analyzed Studies in Terms of Sensitivity, Specificity, PPV, NPV, Accuracy and Interrater Reliability, Cubital Tunnel Syndrome

Article	Nerve of Interest	No. Patients	Sensitivity	Specificity	PPV	NPV	Accuracy	Interrater Reliability [as Measured by (K)]
Cheng et al[3]	Ulnar nerve/CuTS	64	0.69	0.99	0.99	0.86	89%	0.98
Montgomery et al[8]	Ulnar nerve/CuTS	8	0.1	0.9	*	*	*	– 0.025 (resident/technician 1) 0.211 (resident/technician 2)
Pisquiy et al[9]	Ulnar nerve/CuTS	49	0.89 (SCT on upper) 0.86 (SCT on lower)	*	*	*	*	*

*Information not provided.

Table 3. Numeric Data of the Analyzed Studies in Terms of Sensitivity, Specificity, PPV, NPV, Accuracy, and Interrater Reliability, Peroneal Nerve Entrapment

Article	Nerve of Interest	No. Patients	Sensitivity	Specificity	PPV	NPV	Accuracy	Interrater Reliability [as Measured by (K)]
Gillenwater et al[6]	Peroneal nerve	24	0.77	0.99	0.95	0.92	93%	*

*Information not provided.

ranging from seconds to tens of minutes in tissues and blood and extends up to hours in plasma.[41] Given that SP's presence in tissues and plasma exceeds the momentary duration of the SCT, it seems less plausible as a mechanism of triggering transient loss of voluntary muscle activation and establishes the CSP as the stronger hypothesis.

Regarding the diagnostic utility of the SCT, large variation (ie, heterogeneity) was seen when comparing the sensitivity, specificity, PPV, and NPV values from all studies with sufficient numerical data for analysis. For example, the sensitivity values of the SCT for patients with CTS ranged from 0.08 to 0.88, with a mean (±SD) of 0.442 ± 0.272. The variation in sensitivity values of the SCT for cubital tunnel syndrome (CuTS) echoed that of CTS above, with a range from 0.10 to 0.89 and a mean (±SD) of 0.635 ± 0.367. For reference, similar variability is seen with the Tinel sign, with sensitivity and specificity values ranging 0.32–1.0 and 0.55–1.0, respectively.[3,42] As demonstrated by the magnitude of SD values, the wide range of diagnostic validity was present across all studies, including specificity, PPV, NPV, and accuracy values.

Although a meta-analysis is possible based on the available clinical data, we did not find this to be warranted due to the statistical heterogeneity present among included studies. In the setting of statistical heterogeneity, a meta-analysis would likely yield invalid conclusions regarding the clinical utility of the SCT. A recent meta-analysis attempt pools this heterogenous data to provide an adverse summary recommendation against the use of the SCT.[34] Their approach can be interpreted as presuming the statistical heterogeneity among SCT outcome studies to be an inherent characteristic of the SCT, as opposed to a correctable error in performance or use of the test. If an inherent flaw of the SCT itself existed, then a low specificity should also be seen, as opposed to the relatively high specificity found across all studies.

Many explanations have been proposed as to why variable accuracy exists within these studies, including poor reliability (κ) between examiners, variability in anatomical localization, and subjective interpretation of positive versus negative outcomes. The mean interrater reliability was κ = 0.544, indicating moderate agreement, with a wide range from – 0.025 (none) to 0.98 (excellent). Current accepted guidelines indicate κ values less than or equal to 0 as no agreement, 0.01–0.20 as none to slight, 0.21–0.40 as fair, 0.41–0.60 as moderate, 0.61–0.80 as substantial, and 0.81–1.00 as excellent agreement.[43] Next, the accuracy of the SCT is highly dependent on the expertise of the examiner in peripheral nerve anatomy and relevant surface landmarks, as an accurate test requires the examiner to "scratch" at the exact anatomic location of compression and with the correct amount of pressure to elicit the response. Finally, the test can be performed by the examiner using varying amounts of internal rotation force applied against the patient's isometric external rotation effort (resistance against internal rotation), and requires full cooperation and correct form by the patient. Previous attempts to improve interrater reliability include demonstration of proper methodology through written word, images, and video; unfortunately, there continues to be a wide range of examiner performance resulting in high interrater reliability.[37] Given the subjective nature of the test, it remains challenging to define what each examiner determines to be a sufficient applied force or a corresponding lapse in resistance from the patient when achieving a "positive" collapse. All these factors increase the error margin.

As the SCT is not standardized, inconsistent methodology within the clinical execution of the test may contribute to variable results. Three potential technique-related flaws include the following: (1) the patient or examiner is providing inconsistent effort, (2) the examiner is pushing too hard, or (3) the examiner is not pushing hard enough. Our analysis of included studies indicates that specificity and PPV are generally high, but sensitivity and NPV are low compared with other provocative tests, suggesting that most examiners are likely not pushing hard enough to elicit the "positive" collapse when false negative findings occur (ie, patient has compression but SCT is negative).

The inverse would be true if the examiner were pushing too hard, thereby eliciting more false positives and decreasing the PPV and specificity. Inconsistent effort on behalf of the examiner or the patient would demonstrate variable results, which may also be present in the included studies showing low sensitivity and specificity. Anecdotally, we have recently found that applying resisted force in the incorrect location, (ie, pushing against the dorsal hands distal to the wrist joint), can increase the frequency of false positive "collapse" findings.

Many articles discuss using the SCT at additional anatomical sites of compression neuropathy with no existing gold standard diagnostic test, demonstrating the significant potential for application of the test as it is quick and simple to perform.[3,6] We recommend the following criteria to determine if a nerve is suitable for assessment by the SCT:

1. The nerve tract must be anatomically distinct for the examiner to scratch the precise location of compression.
2. The nerve itself must have a defined somatotopic distribution for assessment of clinical symptoms.
3. The patient's overall condition, whether related to the affected nerve or not, must permit sufficient shoulder external rotation strength to perform the SCT. New evidence suggests that hip external rotation may also serve as a surrogate for shoulder external rotation when performing the SCT and may lend additional insight on possible physiologic mechanisms underlying the SCT.[9]

Our systematic review has provided insight into (1) the incompletely realized potential for clinical application of the SCT, and (2) the unmet need for future research to create an objective version of the SCT which overcomes the challenges in providing consistent diagnostic accuracy. One previous study attempted an objective measurement of the SCT; however, based on the included figure that appears to test internal rotation force in lieu of external rotation force, that study was excluded from our review.[44] Our future work will focus on removing the confounding factors leading to low interrater reliability (κ) and high subjectivity, to provide an objective form of the SCT with more uniform accuracy and thus greater acceptance as a clinical tool for diagnosis.

Limitations of our review include that the low number of studies included limits the strength of our conclusions. We attempted to lower the risk of reporting bias by searching in seven databases, including two languages, and expanding the review to include different anatomic sites.

Another limitation is the heterogeneity of the included studies. Statistical heterogeneity was demonstrated in clinical utility outcome metrics as described above. There was also clinical heterogeneity with variable anatomic sites of compression neuropathy studied; we addressed this by only pooling data from studies that evaluated the same compression syndrome. There was also variation in specific methodology pertaining to type of examiner (physician, resident, health professionals), blinding versus nonblinding of results from other diagnostic studies, and number of patients examined. Previous studies have shown a substantial risk of bias inherent to these studies given that patients are not drawn from a general patient population.[5,36] Additionally, the studies use varying control data sets which creates further discrepancy. Despite these limitations, included studies were prospective and provided similar data analysis using the SCT and a confirmatory electrodiagnostic test as the diagnostic standard. Therefore, the above differences were considered and should not invalidate our findings.

CONCLUSIONS

Given the significant statistical heterogeneity demonstrated in this review, a more objective implementation of the SCT should be developed to optimize interrater reliability, reduce potential examiner bias, and expand its clinical application. Additionally, more research is needed to demonstrate the utility of the SCT at additional anatomical sites of compression neuropathy, in the form of sensitivity and specificity data.

Alicia M. Faszholz, MS2
951 Easy St.
Grapevine, TX 76051
E-mail: alicia.faszholz@tcu.edu

DISCLOSURE

The authors have no financial interest to declare in relation to the content of this article.

ACKNOWLEDGMENTS

We thank Macie Sherman, BA for her valuable assistance on Figure 1A and 1B.

REFERENCES

1. Faktorovich S, Filatov A, Rizvi Z. Common compression neuropathies. *Clin Geriatr Med.* 2021;37:241–252.
2. Nakashian MN, Ireland D, Kane PM. Cubital tunnel syndrome: current concepts. *Curr Rev Musculoskelet Med.* 2020;13:520–524.
3. Cheng CJ, Mackinnon-Patterson B, Beck JL, et al. Scratch collapse test for evaluation of carpal and cubital tunnel syndrome. *J Hand Surg Am.* 2008;33:1518–1524.
4. LaJoie AS, McCabe SJ, Thomas B, et al. Determining the sensitivity and specificity of common diagnostic tests for carpal tunnel syndrome using latent class analysis. *Plast Reconstr Surg.* 2005;116:502–507.
5. Čebron U, Curtin CM. The scratch collapse test: a systematic review. *J Plast Reconstr Aesthet Surg.* 2018;71:1693–1703.
6. Gillenwater J, Cheng J, Mackinnon SE. Evaluation of the scratch collapse test in peroneal nerve compression. *Plast Reconstr Surg.* 2011;128:933–939.
7. Blok RD, Becker SJ, Ring DC. Diagnosis of carpal tunnel syndrome: interobserver reliability of the blinded scratch-collapse test. *J Hand Microsurg.* 2014;6:5–7.
8. Montgomery K, Wolff G, Boyd KU. Evaluation of the scratch collapse test for carpal and cubital tunnel syndrome-a prospective, blinded study. *J Hand Surg Am.* 2020;45:512–517.
9. Pisquiy JJ, Carter JT, Gonzalez GA. Validity of using the scratch collapse test in the lower extremities. *Plast Reconstr Surg.* 2022;150:194e–200e.
10. Özdemir A, Güleç A, Yurteri A, et al. Effect of pronator teres muscle botulinum neurotoxin type-A injection on proximal median nerve entrapment. *Hand Surg Rehabil.* 2023;43:101604.

11. Hagert E. Clinical diagnosis and wide-awake surgical treatment of proximal median nerve entrapment at the elbow: a prospective study. *Hand (N Y).* 2013;8:41–46.
12. Ishikhov IM, Kolomiets KV, Gamidov FM, et al. Bilateral lacertus fibrosus entrapment of median nerve at the elbow (lacertus syndrome). *Bull Russ State Med Univ.* 2021;(2):58–61.
13. Areson DG, Filer WG, Harris MG, et al. Accuracy of the scratch collapse test for carpal tunnel syndrome in comparison with electrodiagnostic studies. *Hand (N Y).* 2022;17:630–634.
14. Makanji HS, Becker SJ, Mudgal CS, et al. Evaluation of the scratch collapse test for the diagnosis of carpal tunnel syndrome. *J Hand Surg Eur Vol.* 2014;39:181–186.
15. Simon J, Lutsky K, Maltenfort M, et al. The accuracy of the scratch collapse test performed by blinded examiners on patients with suspected carpal tunnel syndrome assessed by electrodiagnostic studies. *J Hand Surg Am.* 2017;42:386.e1–386.e5.
16. Mazhar FN, Shariatzadeh H, Hosseinzadeh D. Diagnostic capability of the scratch collapse test compared with other clinical diagnostic tests for diagnosis of carpal tunnel syndrome: a prospective case-control study. *Curr Orthop Pract.* 2023;34:5–8.
17. Cao J, Jia T, Lao J, et al. Evaluation of different physical examination methods for the diagnosis of carpal tunnel syndrome. *World Acad Sci J.* 2022;4:33.
18. Bahadır CT, Bahadır S. The accuracy of provocative tests on diabetic patients with suspected carpal tunnel syndome and comparison with nondiabetics. *Acta Medica.* 2022;53:173–179.
19. Hagert E, Hagert CG. Upper extremity nerve entrapments: the axillary and radial nerves–clinical diagnosis and surgical treatment. *Plast Reconstr Surg.* 2014;134:71–80.
20. Meyer LE, Blevins KM, Long JS, et al. Quadrangular space decompression. *Video J Sports Med.* 2022;2:263502542110710.
21. Chim H. The scratch collapse test for diagnosis and treatment of trigger sites for migraine surgery. *Plast Reconstr Surg Glob Open.* 2022;10:e4145.
22. Page PS, Hanna AS. Letter: paraspinal scratch collapse test for cervical radiculopathy. *Neurosurgery.* 2022;90:e189.
23. Greeneway GP, Page PS, Navarro MA, et al. Supraclavius muscle observed during anterior scalenectomy for thoracic outlet syndrome: a report of two cases and review of the literature. *Surg Neurol Int.* 2022;13:600.
24. Schaap L, Jacobs M, Scheltinga MRM, et al. The scratch collapse test in patients diagnosed with anterior cutaneous nerve entrapment syndrome (ACNES): a report of three cases. *Int J Surg Case Rep.* 2023;105:108099.
25. Cho W-c, Son B-c. Delayed diagnosis of meralgia paresthetica: a case report. *Nerve.* 2018;4:82–85.
26. Turan I, Hagert E, Jakobsson J. *The scratch collapse test supported the diagnosis and showed successful treatment of tarsal tunnel syndrome. J Med Cases* 2013; 4:746–47.
27. Kao DS, Cheng J. *Peripheral Neuropathy: Surgical Approaches Simplified for the Imagers.* New York, NY: Thieme Medical Publishers; 2015:121–129.
28. Pinder EM, Ng CY. Scratch collapse test is a useful clinical sign in assessing long thoracic nerve entrapment. *J Hand Microsurg.* 2016;8:122–124.
29. Davidge KM, Gontre G, Tang D, et al. The "hierarchical" scratch collapse test for identifying multilevel ulnar nerve compression. *Hand (N Y).* 2015;10:388–395.
30. Haddaway NR, Page MJ, Pritchard CC, et al. PRISMA2020: an R package and Shiny app for producing PRISMA 2020-compliant flow diagrams, with interactivity for optimised digital transparency and Open Synthesis. *Campbell Syst Rev.* 2022;18:e1230.
31. ASPS Evidence Rating Scales. Available at https://www.plasticsurgery.org/documents/medical-professionals/health-policy/evidence-practice/ASPS-Rating-Scale-March-2011.pdf. Published March 2011. Accessed December 10, 2023.
32. Margaliot Z, Chung KC. Systematic reviews: a primer for plastic surgery research. *Plast Reconstr Surg.* 2007;120:1834–1841.
33. Brown JM, Mokhtee D, Evangelista MS, et al. Scratch collapse test localizes Osborne's band as the point of maximal nerve compression in cubital tunnel syndrome. *Hand (N Y).* 2010;5:141–147.
34. Jain NS, Zukotynski B, Barr ML, et al. The scratch-collapse test: a systematic review and statistical analysis. *Hand (N Y).* 2023:15589447231174483.
35. Ozdag Y, Hu Y, Hayes DS, et al. Sensitivity and specificity of examination maneuvers for carpal tunnel syndrome: a meta-analysis. *Cureus.* 2023;15:e42383.
36. Huynh MNQ, Karir A, Bennett A. Scratch collapse test for carpal tunnel syndrome: a systematic review and meta-analysis. *Plast Reconstr Surg Glob Open.* 2018;6:e1933.
37. Kahn LC, Yee A, Mackinnon SE. Important details in performing and interpreting the scratch collapse test. *Plast Reconstr Surg.* 2018;141:399–407.
38. Kofler M, Leis AA, Valls-Sole J. Cutaneous silent periods—part 2: update on pathophysiology and clinical utility. *Clin Neurophysiol.* 2019;130:604–615.
39. Kofler M, Leis AA, Valls-Sole J. Cutaneous silent periods - Part 1: update on physiological mechanisms. *Clin Neurophysiol.* 2019;130:588–603.
40. Öztürk N, Erin N, Tüzüner S. Changes in tissue substance P levels in patients with carpal tunnel syndrome. *Neurosurgery.* 2010;67:1655–1660; discussion 1660.
41. Mashaghi A, Marmalidou A, Tehrani M, et al. Neuropeptide substance P and the immune response. *Cell Mol Life Sci.* 2016;73:4249–4264.
42. Brüske J, Bednarski M, Grzelec H, et al. The usefulness of the Phalen test and the Hoffmann-Tinel sign in the diagnosis of carpal tunnel syndrome. *Acta Orthop Belg.* 2002;68:141–145.
43. McHugh ML. Interrater reliability: the kappa statistic. *Biochem Med (Zagreb).* 2012;22:276–282.
44. García-Medrano B, Simón Pérez CL, Corella Montoya MA, et al. Objective evaluation of the "scratch collapse test" for the diagnosis of carpal tunnel syndrome. *Injury.* 2021;52(Suppl 4):S145–S150.