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The value of provocative tests for the wrist and elbow: A literature review

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ABSTRACT

To describe and determine the usefulness of provocative tests for the wrist and elbow a literature search was performed. A total of 31 diagnostic studies were identified, assessed, and ranked. The highest ranking tests had a mean positive likelihood ratio of ≥2.0, or a mean negative likelihood ratio of ≤0.5, from more than one study. The highly recommended tests were found to be the Phalen's, Tinel's test for carpal tunnel and cubital tunnel, and modified compression test, scaphoid shift test, and elbow flexion test. A total of 14 tests met our requirements to be considered a recommended test. A greater number of provocative tests either do not have adequate data to support their usefulness or their clinical utility has not been assessed. This information may assist hand therapists in choosing which provocative tests are considered clinically useful in improving the probability of the presence or absence of pathology in the hand, wrist, and elbow.
Level of evidence: NA.

Introduction

Provocative testing is a mainstay component of the evaluative approach in hand therapy. Hand therapists often couple the results of provocative tests with other clinical indicators to determine whether a specific pathological condition of the hand, wrist, or elbow exists. Provocative tests, defined as any procedure in which a suspected pathology is deliberately induced by manipulating conditions known to provoke the abnormality, are considered clinically useful: especially when trying to determine the presence (or absence) of common pathologies involving nerves, tendons, ligaments, joint capsules, bones, and articular cartilage. The likelihood of successfully identifying a pathologic condition increases with judicious use of relevant provocative test results.[1]

Many upper extremity pathological conditions have a proposed provocative test maneuver clinicians use to determine the presence of the condition. How well these test maneuvers have been studied varies. Some common tests such as the Finkelstein's test[2] for stenosing tenosynovitis and the Mill's test for lateral epicondylitis[3] have not been studied to date. Conversely, tests to determine the presence of nerve compression at the wrist or elbow have been examined more often. However systematic reviews of clinical tests used in the diagnosis of CTS found many of the studies had methodological flaws and lacked the necessary details needed to replicate the studies.[4,5]

When researchers study the accuracy of a diagnostic testing method, data regarding the sensitivity and specificity value of the test is provided. The sensitivity or specificity of a diagnostic test refers to how likely the test will "rule in" or "rule out" the suspected diagnosis with a positive or negative test result. For example, the sensitivity of the Phalen's test is the proportion of people who have carpal tunnel have a positive test result. However, some people who have carpal tunnel will not have a positive test result and some people who do not have carpal tunnel will have a positive test result. Therefore, the sensitivity and specificity values of a test do not provide the clinician with the most useful information when making the decision regarding the usefulness of the test.[1] Sensitivity and specificity values can be used as independent estimates of the usefulness of negative and positive test results, but the values should be considered independent from one another.[1] Sensitivity and specificity values do not take into consideration the pretest probability that the condition is present, so they cannot be used to quantify the shift in probability of the condition using the test results.[1]

As standards for diagnostic research improve over time, newer studies may contain information such as positive predictive values and likelihood ratios that many of the earlier studies did not contain. Predictive values can be more useful than specificity and sensitivity values because the predictive value provides the probability that the negative or positive test result is correct.[1] However, the predictive values can provide the clinician with deceptive

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information because the values are highly dependent on the prevalence of the condition of interest in the sample population. For example, the positive predictive values (PPV) will be lower and negative predictive values (NPV) will be higher in a sample of patients with carpal tunnel if only a small percentage of the patients in the study have carpal tunnel syndrome. If most of the patients in the sample have carpal tunnel, then the PPV will be higher and the NPV will be artificially lower.[1] Positive and negative likelihood ratios provide more useful and accurate information to the clinician than NPV and PPV, because the likelihood ratio is calculated in a manner not dependent on the prevalence of the condition in the sample population. The likelihood ratio (LR) is an important statistic for summarizing diagnostic accuracy.[6] The likelihood ratio, which combines information from sensitivity and specificity, gives an indication of how much the odds of disease change based on a positive or a negative result. Likelihood ratios reflect a combination of the information contained in sensitivity and specificity values into a ratio that can be used to quantify shifts in probability once the diagnostic test results are known.[7]

The LR allows the clinician to determine the probability that a target pathology is present by relating the result of the test with the pre-test probability. An LR greater than 1 indicates that the test result is associated with the pathology. An LR less than 1 indicates that the test result is associated with absence of the pathology. Tests where the LR lies close to 1 have little clinical significance as the post-test probability (odds) is little different from the pre-test probability, and as such is not used for screening purposes. The diagnostic accuracy of any maneuver is considered useful if the positive LR is 2.0 or greater or if the negative LR is 0.50 or less.[8] Thus, the LR can be clinically useful to determine the probability of identifying the presence or absence of pathology.[1]

We have attempted to rate the clinical usefulness of provocative tests using criterion-based cut points for assessing studies and likelihood ratios for various provocative tests. The purpose of this quantitative narrative review is two-fold: 1) to identify and describe provocative tests that meet our criteria as being able to determine the presence or absence of pathology in the hand, wrist, and elbow; and 2) to assist hand therapists in choosing which provocative tests are considered clinically useful in improving the probability of identifying the presence or absence of pathology in the hand, wrist, and elbow.

Materials and methods

In an effort to describe and determine the usefulness of provocative tests for the hand, wrist, and elbow a literature search was performed using the keywords: provocative test, sensitivity, specificity, likelihood ratios, diagnostic test, and pathological conditions of the hand, wrist, and elbow (Fig. 1). A total of 31 diagnostic studies that examined/described 47 tests were identified. Fifteen studies between 2004 and 2010 examined 21 tests for carpal tunnel syndrome were included in this study. Carpal tunnel studies published prior to 2004 were previously reviewed by MacDermid[5] for their diagnostic accuracy and therefore not a part of this review. There were ten studies included from 1994 to 2011 that examined 13 provocative tests commonly used to determine wrist instability and pathologic conditions of the distal radioulnar joint. Also included were studies performed by four separate groups of researchers between 1980 and 2011 on 7 provocative tests to determine the presence or absence of cubital tunnel syndrome and three studies on 6 provocative tests to determine the presence of elbow instability. To the best of our knowledge, there were no additional diagnostic studies found for other provocative tests reported in the literature.

Establishing criterion-based cut points

These studies were then assessed, and graded according to the 12-point MacDermid scale for determining the quality of the research process.[5] Essential components included a blinded evaluation, a gold standard reference as applied to all patients in the study, and the selection of appropriate patients and control subjects.[5] The studies in our review ranged in score from 4/12 to 12/12. The original 12-point scale designed by MacDermid[5] was used in this study, rather than the suggested 14-point scale, because the authors of this study believed that the testers in the predominance of these studies were either physicians or therapists who had the appropriate skills and expertise to reliably perform the tests.

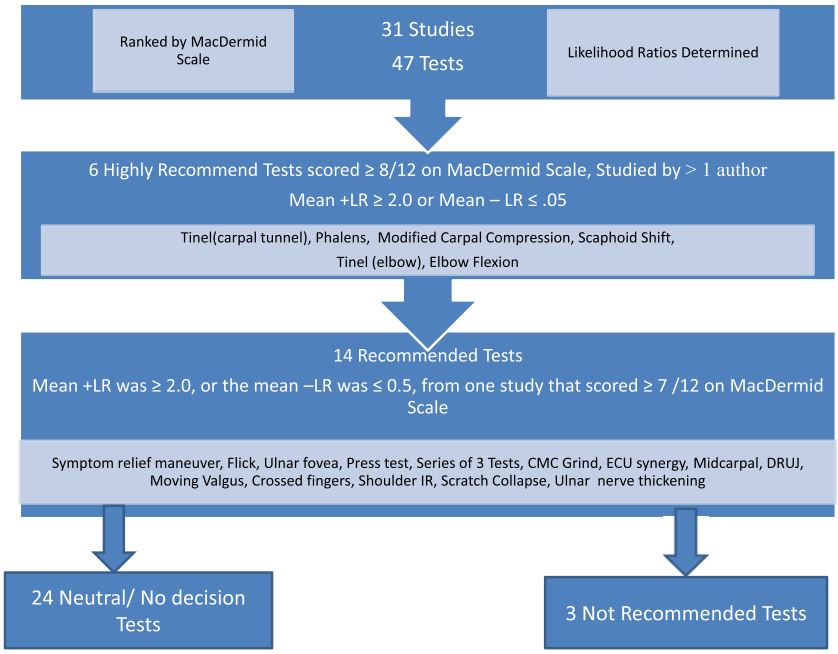

Fig. 1. Flow diagram of categorization process.

Establishing an objective method for synthesis of the retrieved information was performed by establishing cutoff scores. A score of 8/12 indicated that the study met a preponderance of the requisite criteria. If a study scored less than 7/12 on the MacDermid[5] scale, the study was considered to be of poorer quality.

Establishing likelihood ratios

We utilized likelihood ratios reported by the authors of the identified studies. If the LR was not reported by the authors, then it could be determined from the reported data we calculated it as follows:

The likelihood ratio of a positive test result (LR+) is sensitivity divided by 1 − specificity.
The likelihood ratio of a negative test result (LR−) is 1 − sensitivity divided by specificity.

The resultant mean values were found by adding the studies' individual LR values and then dividing the sum by the number of studies. The accuracy of this method cannot be determined because some studies had a higher number of subjects than others.

Highly recommended

Provocative tests were categorized as highly recommended if the resultant mean positive likelihood ratio was ≥2.0, or a mean negative likelihood ratio was ≤0.5, from two or more studies that scored ≥8/12 on the MacDermid rating scale.[5]

Recommended

Provocative tests were categorized as recommended if the resultant mean positive likelihood ratio was ≥2.0, or the mean negative likelihood ratio was ≤0.5, from one study that scored ≥ 7/12 on the MacDermid scale.[5]

Neutral/no decision

Provocative tests that did not meet our criteria, i.e., the cut points, we reserved them into a neutral/no decision category.

Not recommended

If a test had poor metrics, or was unable to be performed clinically due to the necessity of specific equipment required to perform the test, it was placed in the not recommended category.

Results

Highly recommended tests

Six tests met our predetermined cut points to be considered a highly recommended test. Although some tests met the LR specifications, they were not reported in two or more studies and were thus relegated to the recommended category. The highly recommended provocative tests were found to be the Phalen's,[9] Tinel's,[10] and modified compression test[11] for carpal tunnel syndrome; the scaphoid shift test[12] for scapholunate instability; and the Tinel's[13] and elbow flexion test[13] for cubital tunnel syndrome (Table 1).

Recommended tests

A total of 14 tests met our requirements to be considered recommended. The recommended tests for determining the presence or absence of carpal tunnel syndrome are the flick test[24] and the symptom relief maneuver.[24] Seven tests met the requirements to be considered a recommended test for various wrist and distal radioulnar joint (DRUJ) pathological conditions. The carpometacarpal (CMC) grind test[25] is recommend for determining the presence of

Table 1
Highly recommended provocative tests for the wrist & elbow

Test	Author, year	MacDermid[5] study score	+LR	−LR
Wrist neuropathy testing				
Phalen's	LaJoie, 2005[14]	8/12	7.6	0.09
	Boland, 2009[15]	9/12	2.54	0.49
	Wainner, 2005[16]	10/12	1.3	0.50
	Amerifeyz, 2005[17]	8/12	0.98	0.85
	Tekeoglu, 2007[11]	10/12	1.0	0.77
		Mean	**2.68**	**0.54**
Tinel's	LaJoie, 2005[14]	8/12	10.77	0.03
	Wainner, 2005[16]	10/12	1.4	0.78
	Cheng, 2008[13]	9/12	0.96	0.59
	Amerifeyz, 2005[17]	8/12	0.64	0.71
	Tekeoglu, 2007[11]	10/12	1.0	0.75
		Mean	**2.95**	**0.57**
Modified compression test	Boland, 2009[15]	9/12	3.64	0.89
	Tekeoglu, 2007[11]	10/12	0.92	0.93
		Mean	**2.28**	**0.91**
Wrist musculoskeletal pathology testing				
Scaphoid shift	Wolfe, 1994[18]	8/12	4.7	0.17
	Wolfe, 1997[19]	9/12	1.68	0
	Prosser, 2011[20]	10/12	2.88	0.28
	LaStayo, 1995[21]	10/12	1.78	0.55
		Mean	**2.76**	**0.25**
Elbow neuropathology testing				
Tinel	Cheng, 2008[13]	8/12	53.99	0.46
	Beekman, 2009[22]	9/12	1.3	0.72
		Mean	**27.65**	**0.59**
Elbow flexion	Beekman, 2009[22]	9/12	1.0	0.99
	Ochi, 2011[23]	8/12	Infinity	0.64
	Cheng, 2008[13]	9/12	45.99	0.54
		Mean	**27.66**	**0.72**

Bold numerical values are the resultant mean likelihood ratios.

Table 2
Reasonable provocative tests for the hand, wrist & elbow

Test	Author, year	MacDermid[5] study score	+LR	−LR
Wrist neuropathy testing				
Symptom relief maneuver	Gok, 2008[24]	9/12	3.3	0.39
Flick	Gok, 2008[24]	9/12	5.9	0.22
Wrist musculoskeletal pathology testing				
Ulnar fovea	Tay, 2007[27]	11/12	7.06	0.05
Press test	Lester, 1995[26]	7/12	Infinity	0
Series of 3 tests	Christodoulou, 1999[28]	8/12	16.22	0.24
CMC grind	Merritt, 2010[25]	12/12	4.45	0.60
ECU synergy	Ruland, 2008[29]	9/12	2.9	0
Midcarpal	Prosser, 2011[20]	10/12	2.67	Not calculated
DRUJ	Prosser, 2011[20]	10/12	1.79	0.30
Elbow neuropathy testing				
Scratch collapse	Cheng, 2008[13]	9/12	68.99	0.31
Ulnar nerve thickening	Beekman, 2009[22]	9/12	2.2	0.82
Shoulder IR	Ochi, 2011[23]	8/12	Infinity	0.19
Crossed fingers	Earle, 1980[31]	8/12	Infinity	0.36
Elbow musculoskeletal pathology testing				
Moving valgus stress test	O'Driscoll, 2005[30]	9/12	Infinity	0.05

+LR = positive likelihood ratio; −LR = negative likelihood ratio; DRUJ = distal radioulnar joint; CMC = carpometacarpal; IR = internal rotation.

osteoarthritis (OA) at the base of the thumb. The DRUJ[20] and the press test[26] are recommended tests to determine pathology at the DRUJ. The midcarpal test[20] is a recommended test for assessing the integrity of the arcuate ligament of the wrist. The ulnar fovea sign[27] is a recommended clinical maneuver to detect foveal disruptions and/or ulnotriquetral (UT) ligament injuries. The series of three tests described by Christodoulou and Bainbridge[28] is considered a recommended test when attempting to diagnose peritriquetral injuries. The extensor carpi ulnaris (ECU) synergy test[29] is a recommended test for diagnosing ECU tendonitis in the clinical setting. Four tests are recommended when determining elbow pathology. The moving valgus stress[30] is recommended when determining the presence of medial collateral ligament instability. The crossed fingers,[31] shoulder internal rotation,[23] scratch collapse test,[13] and ulnar nerve thickening sign[22] are also recommended when determining the presence of cubital tunnel syndrome (Table 2).

Neutral/no decision tests

We refrain from making any recommendation as to the clinical usefulness on 24 tests in terms of their ability to determine the presence or absence of pathology of conditions of the hand, wrist, and elbow. At this point, these tests may not be considered useful, though it may be that they have not been tested sufficiently to determine their utility, hence the neutral/no decision category. These tests either had positive LR below 2 or negative LRs above 0.5. Fifteen provocative carpal tunnel syndrome tests that fall into the neutral/no decision category include: the carpal compression test,[32] tourniquet test,[32] hand elevation test,[33] Phalen's wrist extension,[32] Tanzer's,[32] postural provocation test,[32] constant pressure on lunate,[32] pneumatic compression test,[11] Okutsu[34] upper limb tension test Part A,[16] upper limb tension test Part B,[16] upper limb neurodynamic test,[35] combined wrist flexion and carpal compression test,[13] scratch collapse test,[13] and Phalen's combined with sensory testing.[36] The five wrist provocative test maneuvers that fall in the same neutral/no decision category include: the ulnomeniscotriquetral dorsal glide,[21] ballottement,[21] lunotriquetral,[21] GRIT,[20] and ulnocarpal stress test.[37] The ulnar nerve tenderness sign[22] that Beckman described to determine the presence or absence of cubital tunnel was relegated to the neutral/no decision category. The chair sign,[38] push-up sign,[38] and the tabletop relocation test[39] were the three elbow provocative tests that fell into the neutral/no recommendation category (Table 3). Many commonly used provocative test procedures have not been studied to determine their diagnostic accuracy (Appendix 1). Although these tests are apparently used by clinicians, their diagnostic accuracy has not yet been determined, therefore, their clinical usefulness have not been established.

Not recommended tests

Three tests met our requirements to be considered not recommended. The ratio of thumb abduction strength to the index

Table 3
Neutral/no recommendation provocative tests for the wrist & elbow

Test	Author, year	MacDermid[5] study score	+LR	−LR
Wrist neuropathology testing				
Carpal compression test	Amirfeyz, 2011[40]	7/12	0.80	0.83
	Goloborod'ko, 2004[32]	7/12	0.88	0.90
	Wainner, 2005[16]	10/12	0.91	1.2
	El Miedany, 2008[41]	7/12	0.61	2.16
		Mean	**0.80**	**1.27**
Tourniquet test	Amirfeyz, 2011[40]	7/12	0.72	0.90
	Goloborod'ko, 2004[32]	7/12	0.95	0.87
		Mean	**0.83**	**0.89**
Hand elevation test	Amirfeyz, 2011[40]	7/12	0.92	0.99
	Amirfeyz, 2005[17]	8/12	0.98	0.88
		Mean	**0.95**	**0.94**
Phalen's wrist extension	Goloborod'ko, 2004[32]	7/12	0.92	0.88
	El Miedany, 2008[41]	7/12	0.64	1.65
	Yoshida, 2010[34]	7/12	1	Unable to calculate
		Mean	**0.85**	**1.27**
Tanzer's	Goloborod'ko, 2004[32]	7/12	0.91	0.79
Postural provocation	Goloborod'ko, 2004[32]	7/12	0.98	0.98
Constant pressure on lunate	Goloborod'ko, 2004[32]	7/12	0.98	0.98
Pneumatic compression test	Tekeoglu, 2007[11]	10/12	0.98	0.83
Okutsu	Yoshida, 2010[34]	7/12	1.0	Unable to calculate
Upper limb tension test Part A	Wainner, 2005[16]	10/12	0.91	1.2
Upper limb tension test Part B	Wainner, 2005[16]	10/12	0.86	1.9
Upper limb neurodynamic test	Vanti, 2011[35]	9/12	1.81	0.65
Combined wrist flexion & carpal compression	Cheng, 2008[13]	9/12	0.98	0.65
Scratch collapse test	Cheng, 2008[13]	9/12	0.99	0.73
Phalen's combined with sensory testing	Bilkis, 2011[36]	6/12	1.0	0.74
Wrist musculoskeletal pathology testing				
Ulnomenisco-triquetral dorsal glide	LaStayo, 1995[21]	10/12	1.2	0.77
Ballottement	LaStayo, 1995[21]	10/12	1.12	0.83
Lunotriquetral test	Prosser, 2011[20]	10/12	1.03	0.80
GRIT	Prosser, 2011[20]	10/12	1.12	0.83
Ulnocarpal stress test	Nakamura, 1997[37]	7/12	1.0	Unable to calculate
Elbow neuropathology testing				
Ulnar nerve tenderness	Beekman, 2009[22]	9/12	1.6	0.85
Elbow musculoskeletal pathology testing				
Chair sign	Regan, 2006[38]	4/10	0.87	Unable to calculate
Push-up sign	Regan, 2006[38]	4/10	0.87	Unable to calculate
Tabletop relocation	Arvind, 2006[39]	4/10	1.0	Unable to calculate

Bold numerical values are the resultant mean likelihood ratios.
+LR = positive likelihood ratio; −LR = negative likelihood ratio; GRIT = gripping rotatory impaction test.

finger[42] requires special testing apparatus that is not available to the clinician. A limitation of the pivot shift test for posterolateral instability of elbow test is that it requires general anesthesia to optimize accuracy.[38] The milking maneuver[50] is used to test medial collateral ligament instability, but has a high rate of false-positive results[53] (Table 4).

Clinical application discussion

The results of our review suggest that there are several provocative test maneuvers that hand therapists can consider to be highly recommended or recommended tests. Many of the most commonly seen pathological conditions treated by clinicians have either a highly recommended or recommended provocative test that can be used to determine the presence of pathology. There are recommended tests to determine median and ulnar nerve pathology in the wrist and elbow, a number of wrist instability conditions, and elbow instability. Many tests commonly used by clinicians, however, have never had their diagnostic accuracy assessed. As more studies, with large number of patients become available the number of recommended tests (using our grading criteria) may increase. Newer studies are more likely than older studies to provide LR data in their findings, and this information will be more useful than simply reporting the sensitivity and specificity of provocative test maneuvers.

When interpreting likelihood ratios from a clinical perspective, a positive LR greater than 1 indicates that a positive provocative test result is more likely to occur in patients with the condition than in patients without the condition. For example, the positive LR of the DRUJ test used for diagnosing distal radioulnar joint pathology is 1.79. This means that a patient with DRUJ pathology is 1.79 times more likely to have a positive test than a patient who does not have DRUJ pathology. A negative LR is defined as the probability of a patient with the condition having a negative test divided by the probability of a patient without the condition having a negative test. The negative LR of the DRUJ is 0.30. This means that the probability of having a negative test result for patients with DRUJ pathology is 0.30 times less or approximately one-third of those without the condition. Patients without DRUJ pathology are three times more likely to have a negative test than individuals with the disease.

Likelihood ratios can be used to help hand therapists adapt the sensitivity and specificity of tests to individual patients. A hand therapist is prompted to perform a particular provocative test after incorporating the history and other findings from the evaluation. As the clinician begins to suspect certain pathology might exist he/she performs testing to rule in or rule out this diagnosis. Before performing the test, the clinician has a general sense of the patient's chance or probability of having the suspected condition. The estimated probability of the condition before the test result is referred to as the pre-test probability. The patient's probability or chance of having the disease after the test results is referred to as the post-test probability. The post-test probability of the pathologic condition is what clinicians and patients are most interested in as this can help in deciding whether to confirm a diagnosis, eliminate a diagnosis from consideration or perform further tests. The results of clinically useful provocative tests are used to modify the pre-test probability and generate an enhanced post-test probability. The Fagan's nomogram[54] (Fig. 2) is a graphical tool, which can be used in routine clinical practice as it allows clinicians to use the results of a diagnostic test to estimate a patient's probability of having the condition. To use the nomogram, a straight line drawn from a patient's pre-test probability of pathology (left axis) courses through the likelihood ratio of the test (middle axis) and intersects with the post-test probability of the disease or pathology (right axis).

The prevalence of carpal tunnel syndrome is between 5 and 15% in population-based studies.[55,56] It is reasonable to assume that the chance of a patient having carpal tunnel is approximately 10%. The mean positive LR of the Tinel test is 2.95. When a straight line is drawn from the pre-test probability of 10% through the likelihood ratio of 2.95, the line intersects with the post-test probability of about 28% (Fig. 3). This means that the probability of the patient having carpal tunnel increased from 10% to 28% based upon the positive test result. In a similar fashion, the post-test probability of a patient having carpal tunnel syndrome can be determined for the individual that has a negative test result. Linking the pre-test probability of 10% to the mean negative LR of the Tinel test of 0.57 on the Fagan's nomogram, one can see the post-test probability is about 0.75% (Fig. 4). This means after a negative test, a patient's chance of having carpal tunnel reduces from 10% to 0.75%. A result in one test will not shift the pre-test probability for a subsequent test. For example, a clinician could not use the post-test

Table 4
Not recommended provocative tests for the wrist & elbow

Test	Author	MacDermid[5] score	+LR	−LR
Wrist neuropathy testing				
Ratio thumb abduction strength/index finger	Agabegi, 2010[42]	7/12	15.5	0.70
Elbow musculoskeletal pathology testing				
Pivot shift test for posterolateral instability of elbow	Regan, 2006[38]	4/12	Unable to calculate	Unable to calculate
Milking maneuver for medial collateral ligament instability	Cain, 2004[50]	Diagnostic accuracy has not been tested		

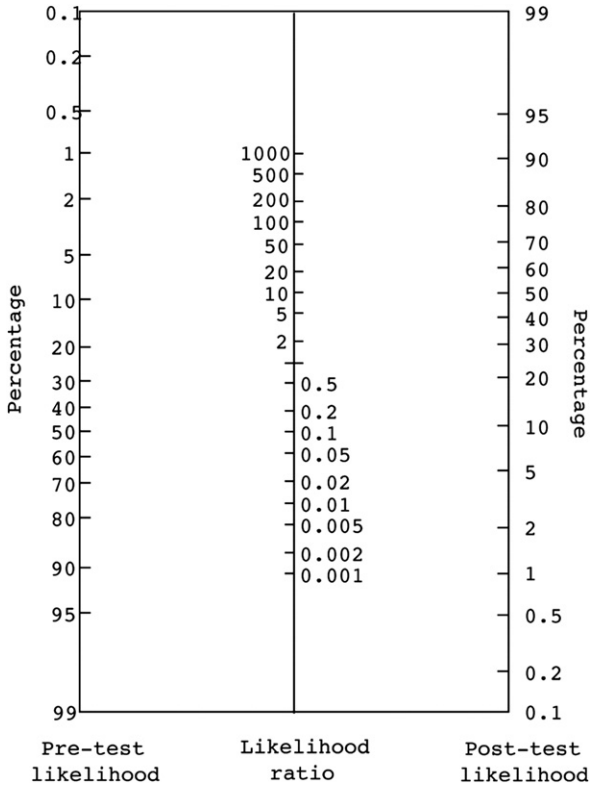

Fig. 2. Fagan's nomogram used for estimating how much the result on a diagnostic test changes the probability that a patient has a condition.

probability of 28% for carpal tunnel after the Tinel test as the pretest probability for a subsequent Phalen's test. A second test may provide little or no useful information and the sequential application of likelihood ratios can yield misleading results.[57] Clinical prediction rules deal with the lack of independence of a series of tests that can be applied to a diagnostic dilemma and can provide the clinician with a way of combining test results.[57] For example a clinician can combine the findings of the Tinel test for carpal tunnel, with the patient's subjective complaints of night pain and paresthesia, and other aspects of the history and physical examination of the patient to accurately classify the patient as being characterized by a high, medium, or low probability of having the condition.

These suggestions stemming from our review are in agreement with those of Prosser et al.[20] who reported that the scaphoid shift test and the midcarpal test are mildly useful for diagnosing wrist injuries. However, we determined that seven additional provocative tests are also considered clinically useful in determining the presence of wrist instability. Our review also supports the recommendation of other researchers regarding the usefulness of the Phalen's test[4,5] and Tinel's test[5] for the diagnosis of carpal tunnel syndrome.[4,5]

Discussion

It is possible that we did not identify all relevant studies in our narrative review. Perhaps we were unable to locate diagnostic studies that did not include the name of the test, provocative test, or the condition being studied in the title of the article. However, we were able to find a number of studies that provided the data necessary to perform this review and it is likely that we gathered a preponderance of the important pieces of evidence in the available peer-reviewed literature.

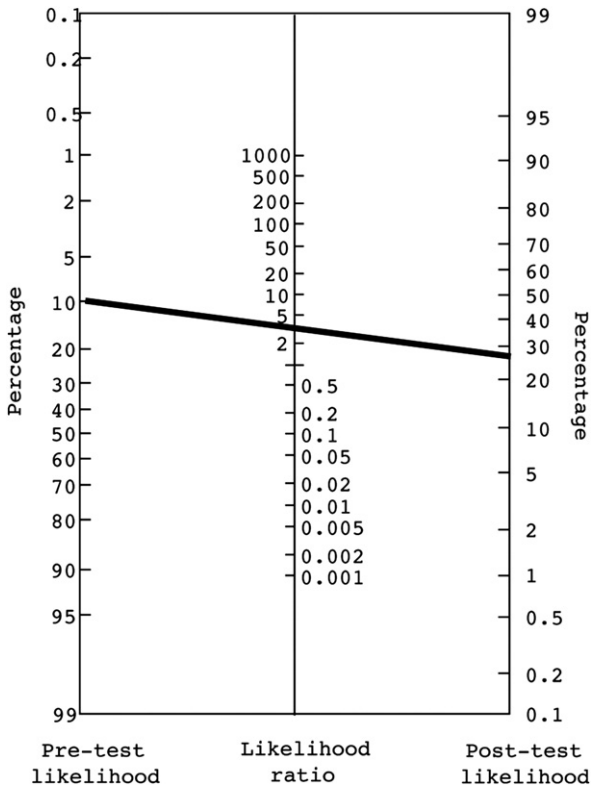

Fig. 3. Example of use Fagan's nomogram to determine a patient's post-test probability of having carpal tunnel syndrome that had a positive Tinel test.

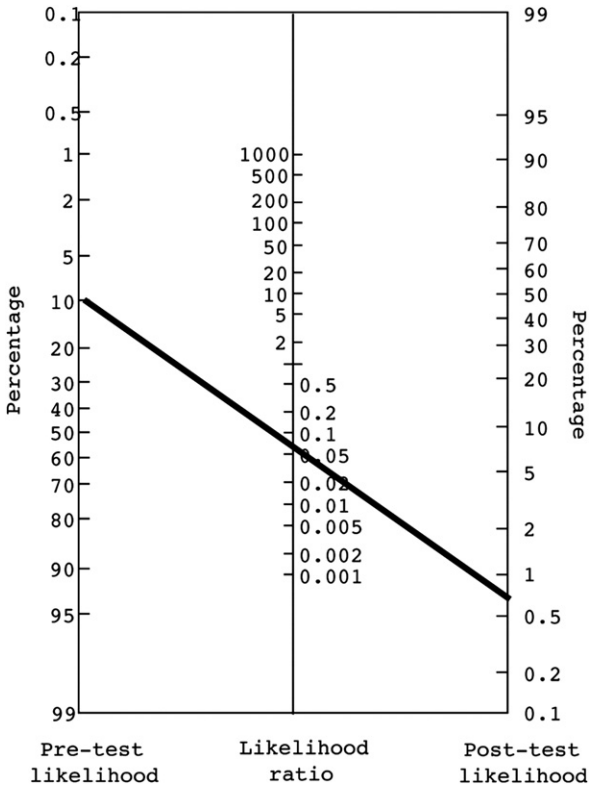

Fig. 4. Example of use Fagan's nomogram to determine a patient's post-test probability of having carpal tunnel syndrome that had a negative Tinel test.

The results of this quantitative narrative review should not be considered conclusive concerning the value of clinical tests in the diagnosis of pathology of the hand, wrist, and elbow. A more rigorous systematic review requires that issues be addressed using specific documented methods that we did not adhere to. Discussions on why certain tests may be better in specific situations or relevant in different stages of pathology are beyond the scope of this review.

Conclusion

Provocative tests are not used in isolation as they make up only one part of the hand therapist's clinical reasoning process. This narrative review establishes a number of provocative tests meet the level of accuracy required to be considered useful when making a diagnosis of the hand, wrist, and elbow. More tests can be considered recommended rather than highly recommended in terms of their clinical utility. An even greater number of provocative tests either do not have adequate data to support their usefulness or their clinical utility has not been assessed.

References

1. Fritz JM, Wainner RS. Examining diagnostic tests: an evidence-based perspective. *Phys Ther*. 2001;81:1546–1564.
2. Finkelstein H. Stenosing tenovaginitis at the radial styloid process. *J Bone Joint Surg Am*. 1930;12:509–540.
3. Mills GP. Treatment of tennis elbow. *Br Med J*. 1928;1:12–13.
4. Massy-Westroop N, Grimmer K, Bain G. A systematic review of the clinical diagnostic tests for carpal tunnel syndrome. *J Hand Surg Am*. 2000;25:120–127.
5. MacDermid JC, Wessel J. Clinical diagnosis of carpal tunnel syndrome: a systematic review. *J Hand Ther*. 2004;17:309–319.
6. Jaeschke R, Guyatt GH, Sackett DL. Users' guides to the medical literature. III. How to use an article about a diagnostic test. B. What are the results and will

they help me in caring for my patients? The Evidence-Based Medicine Working Group. *JAMA*. 1994;271:703–707.
7. Simel DL, Samsa GP, Matchar DB. Likelihood ratios with confidence: sample size estimation for diagnostic test results. *J Clin Epidemiol*. 1991;44:763–770.
8. Holleman D, Simel D. Quantitative assessments from the clinical examination. How should clinicians integrate the numerous results? *J Gen Intern Med*. 1997;12:165–171.
9. Phalen GS, Gardner WJ, La Londe AA. Neuropathy of the median nerve due to compression beneath the transverse carpal ligament. *J Bone Joint Surg Am*. 1950;32A:109–112.
10. Tinel J. Le signe du fourmillement dans les lésions des nerfs périphériques. *Presse Méd*. 1915;47:388–389.
11. Tekeoglu I, Dogan A, Demir G, Dolar E. The pneumatic compression test and modified pneumatic compression test in the diagnosis of carpal tunnel syndrome. *J Hand Surg Eur Vol*. 2007;32:697–699.
12. Watson HK, Ashmead D, Makhlouf MV. Examination of the scaphoid. *J Hand Surg Am*. 1988;13:657–660.
13. Cheng CJ, Mackinnon-Patterson B, Beck JL, Mackinnon SE. Scratch collapse test for evaluation of carpal and cubital tunnel syndrome. *J Hand Surg Am*. 2008;33:1518–1524.
14. LaJoie AS, McCabe SJ, Thomas B, Edgell SE. Determining the sensitivity and specificity of common diagnostic tests for carpal tunnel syndrome using latent class analysis. *Plast Reconstr Surg*. 2005;116:502–507.
15. Boland RA, Kiernan MC. Assessing the accuracy of a combination of clinical tests for identifying carpal tunnel syndrome. *J Clin Neurosci*. 2009;16:929–933.
16. Wainner RS, Fritz JM, Irrgang JJ, Delitto A, Allison S, Boninger ML. Development of a clinical prediction rule for the diagnosis of carpal tunnel syndrome. *Arch Phys Med Rehabil*. 2005;86:609–618.
17. Amirfeyz R, Gozzard C, Leslie IJ. Hand elevation test for assessment of carpal tunnel syndrome. *J Hand Surg Br*. 2005;30:361–364.
18. Wolfe SW, Crisco JJ. Mechanical evaluation of the scaphoid shift test. *J Hand Surg Am*. 1994;19:762–768.
19. Wolfe SW, Gupta A, Crisco JJ 3rd. Kinematics of the scaphoid shift test. *J Hand Surg Am*. 1997;22:801–806.
20. Prosser R, Harvey L, LaStayo P, Hargreaves I, Scougall P, Herbert RD. Provocative wrist tests and MRI are of limited diagnostic value for suspected wrist ligament injuries: a cross-sectional study. *J Physiother*. 2011;57:247–253.
21. LaStayo P, Howell J. Clinical provocative tests used in evaluating wrist pain: a descriptive study. *J Hand Ther*. 1995;8:10–17.
22. Beekman R, Schreuder AH, Rozeman CA, Koehler PJ, Uitdehaag BM. The diagnostic value of provocative clinical tests in ulnar neuropathy at the elbow is marginal. *J Neurol Neurosurg Psychiatry*. 2009;80:1369–1374.
23. Ochi K, Horiuchi Y, Tanabe A, Morita K, Takeda K, Ninomiya K. Comparison of shoulder internal rotation test with the elbow flexion test in the diagnosis of cubital tunnel syndrome. *J Hand Surg Am*. 2011;36:782–787.
24. Gok H, Ay A, Kutlay S. Are relieving maneuvers useful in diagnosis of carpal tunnel syndrome. *Romatizma*. 2008;23:129–134.
25. Merritt MM, Roddey TS, Costello C, Olson S. Diagnostic value of clinical grind test for carpometacarpal osteoarthritis of the thumb. *J Hand Ther*. 2010;23:261–267.
26. Lester B, Halbrecht J, Levy IM, Gaudinez R. "Press test" for office diagnosis of triangular fibrocartilage complex tears of the wrist. *Ann Plast Surg*. 1995;35:41–45.
27. Tay SC, Tomita K, Berger RA. The "ulnar fovea sign" for defining ulnar wrist pain: an analysis of sensitivity and specificity. *J Hand Surg Am*. 2007;32:438–444.
28. Christodoulou L, Bainbridge LC. Clinical diagnosis of triquetrolunate injuries. *J Hand Surg Br*. 1999;24:598–600.
29. Ruland RT, Hogan CJ. The ECU synergy test: an aid to diagnose ECU tendonitis. *J Hand Surg Am*. 2008;33:1777–1782.
30. O'Driscoll SW, Lawton RL, Smith AM. The "moving valgus stress test" for medial collateral ligament tears of the elbow. *Am J Sports Med*. 2005;33:231–239.
31. Earle AS, Vlastou C. Crossed fingers and other tests of ulnar nerve motor function. *J Hand Surg Am*. 1980;5:560–565.
32. Goloborod'ko SA. Provocative test for carpal tunnel syndrome. *J Hand Ther*. 2004;17:344–348.
33. Ahn DS. Hand elevation: a new test for carpal tunnel syndrome. *Ann Plast Surg*. 2001;46:120–124.
34. Yoshida A, Okutsu I, Hamanaka I. A new diagnostic provocation test for carpal tunnel syndrome: Okutsu test. *Hand Surg*. 2010;15:65–69.
35. Vanti C, Bonfiglioli R, Calabrese M, et al. Upper Limb Neurodynamic Test 1 and symptoms reproduction in carpal tunnel syndrome. A validity study. *Man Ther*. 2011;16:258–263.
36. Bilkis S, Loveman DM, Eldridge JA, Ali SA, Kadir A, McConathy W. Modified Phalen's test as an aid in diagnosing carpal tunnel syndrome. *Arthritis Care Res (Hoboken)*. 2012;64:287–289.
37. Nakamura R, Horii E, Imaeda T, Nakao E, Kato H, Watanabe K. The ulnocarpal stress test in the diagnosis of ulnar-sided wrist pain. *J Hand Surg Br*. 1997;22:719–723.
38. Regan W, Lapner PC. Prospective evaluation of two diagnostic apprehension signs for posterolateral instability of the elbow. *J Shoulder Elbow Surg*. 2006;15:344–346.
39. Arvind CH, Hargreaves DG. Tabletop relocation test: a new clinical test for posterolateral rotatory instability of the elbow. *J Shoulder Elbow Surg*. 2006;15:500–501.
40. Amirfeyz R, Clark D, Parsons B, et al. Clinical tests for carpal tunnel syndrome in contemporary practice. *Arch Orthop Trauma Surg*. 2011;131:471–474.
41. El Miedany Y, Ashour S, Youssef S, Mehanna A, Meky FA. Clinical diagnosis of carpal tunnel syndrome: old tests-new concepts. *Joint Bone Spine*. 2008;75:451–457.
42. Agabegi SS, Freiberg RA, Plunkett JM, Stern PJ. Thumb abduction strength measurement in carpal tunnel syndrome. *J Hand Surg Am*. 2007;32:859–866.
43. International Wrist Investigator's Workshop. Meeting of 09-28-92, Kansas City, MO: subsequent newsletter correspondence.
44. Beckenbaugh RD. Accurate evaluation and management of the painful wrist following injury: an approach to carpal instability. *Orthop Clin North Am*. 1984;15:289–306.
45. Stanley J. Radial tunnel syndrome: a surgeon's perspective. *J Hand Ther*. 2006;19:180–184.
46. Loh YC, Lam WL, Stanley JK, Soames RW. A new clinical test for radial tunnel syndrome—the Rule-of-Nine test: a cadaveric study. *J Orthop Surg (Hong Kong)*. 2004;12:83–86.
47. Hartz CR, Linscheid RL, Gramse RR, Daube JR. The pronator teres syndrome: Compression neuropathy of the median nerve. *J Bone Joint Surg Am*. 1981;63A:885–890.
48. Morrey BF. Acute and chronic instability of the elbow. *J Am Acad Orthop Surg*. 1996;4:117–128.
49. Callaway GH, Field LD, Deng XH, et al. Biomechanical evaluation of the medial collateral ligament of the elbow. *J Bone Joint Surg Am*. 1997;79:1223–1231.
50. Cain EL Jr, Dugas JR. History and examination of the thrower's elbow. *Clin Sports Med*. 2004;23:553–566. viii.
51. Roles NC, Maudsley RH. Radial tunnel syndrome: resistant tennis elbow as a nerve entrapment. *J Bone Joint Surg Br*. 1972;54-B:499–508.
52. MacDermid JC, Michlovitz SL. Examination of the elbow: linking diagnosis, prognosis, and outcomes as a framework for maximizing therapy interventions. *J Hand Ther*. 2006;19:82–97.
53. Erne HC, Zouzias IC, Rosenwasser MP. Medial collateral ligament reconstruction in the baseball pitcher's elbow. *Hand Clin*. 2009;25:339–346.
54. Fagan TJ. Letter: Nomogram for Bayes theorem. *N Engl J Med*. 1975;293:257.
55. Katz JN, Larson MG, Sabra A, et al. The carpal tunnel syndrome: diagnostic utility of the history and physical examination findings. *Ann Intern Med*. 1990;112:321–327.
56. de Krom MC, Knipschild PG, Kester AD, Thijs CT, Boekkooi PF, Spaans F. Carpal tunnel syndrome: prevalence in the general population. *J Clin Epidemiol*. 1992;45:373–376.
57. Guyatt G, Rennie D. *Users' Guides to the Medical Literature*. Chicago, IL: AMA; 2002.

Appendix 1. Provocative tests for wrist & elbow

Test	Technique	Positive test	Author, year
Wrist neuropathology testing			
Carpal tunnel syndrome			
Phalen's	Patients fully palmar flexed the wrist with the elbow in full extension and the forearm in pronation for 1 min.	Reproduction of symptoms	Amirfeyz, 2005[17]
Tinel's	Percussion was performed over the course of the median nerve just proximal to and over the carpal tunnel with the wrist in a relaxed position (20° of extension).	A positive test was associated with paresthesia in the median nerve distribution, or an electric shock-like sensation passing into the hand or forearm	Amirfeyz, 2005[17]
Modified pneumatic compression test	Wrapping a blood pressure cuff around the wrist and inflating it to 100 mm/Hg for 30 seconds. A 8 cm long 8 mm diameter wooden pencil-like object lies along the median nerve to apply pressure to the median nerve during the test.	Reproduction of symptoms	Tekeoglu, 2007[11]
Carpal tunnel relief maneuver	Affected hand is maintained with palm up and the distal heads of the metacarpal bones were gently squeezed inducing slight adduction of the fingers.	Relief of symptoms	Gok, 2008[24]
Flick	Patients "flick" their affected hand.	Relief of symptoms	Gok, 2008[24]
Hand elevation	Patients were asked to elevate their hand above their head as high as comfortably possible and to hold it in that position for 1 min.	Reproduction of symptoms within 1 min	Amirfeyz, 2005[17]
Carpal compression test	Examiner applies force over the flexor retinaculum with the patient's forearm supinated.	If the test reproduced symptoms within 30 s	Amirfeyz, 2005[17]
Tourniquet test	Applying pneumatic compression cuff around the arm and inflating it to the systolic blood pressure for 60 s.	If the test reproduced symptoms within the time the cuff was inflated	Amirfeyz, 2011[40]
Constant pressure on lunate	Examiner uses his or her fingers to exert dorsal pressure on the 1st metacarpal and pisotriquetral complex and volar pressure on the lunate.	Reproduction of symptoms	Goloborod'ko, 2004[32]
Phalen's wrist extension	Complete wrist extension for 1 min.	Reproduction of symptoms	El Miedany, 2008[41]
Pneumatic compression test	Wrapping a blood pressure cuff around the wrist and inflating it to 100 mm/Hg for 30 s.	Reproduction of symptoms	Tekeoglu, 2007[11]
Okutsu	Grasping the relaxed patient's hand with the examiners hand, with patient's metacarpophalangeal and interphalangeal joints of the thumb extended passively and with the wrist gently moved along the radial neutral volar–dorsal axis.	Development or increased tingling sensation in any part of the median nerve distribution of the hand	Yoshida, 2010[34]
Upper limb neurodynamic tests (ULNTs)	The ULNT1was performed first on the unaffected or less affected upper limb and subsequently on the affected or more affected one. The shoulder girdle of the tested arm was stabilized in a neutral position without any external device to control it. After this, the shoulder was abducted to approximately 110°, the wrist and fingers were extended, the forearm was supinated, the shoulder was laterally rotated, the elbow was extended, and the cervical spine was actively contralaterally and ipsilaterally flexed. Movements were performed to the end of range or until symptoms were produced. If symptoms were elicited during any step of the ULNT1, the test was stopped and structural differentiation was performed. If no symptoms were elicited, the test was done throughout the full available range.	The test is often considered positive when there is a reproduction of patient's symptoms (e.g., pain, dysesthesia or paresthesia) and "if a movement of a body segment remote from the location of symptoms provoked in the neurodynamic test position alters the response", modifying the symptoms	Vanti, 2011[35]
Combined wrist flexion & carpal compression	Wrist flexion combined with direct compression over the median nerve at the wrist for 60 s.	Reproduction of symptoms	Cheng, 2008[13]
Scratch collapse test	The patient faces the examiner with arms adducted, elbows flexed, and hands outstretched with wrists at neutral. Step **A**: The patient resists bilateral shoulder adduction/internal rotation to the forearms applied by the examiner. Step **B**: Next, the examiner "scratches" or swipes with fingertips over the course of the compressed nerve. Step **C**: Step **A** is immediately repeated. Brief temporary loss of the patient's external resistance tone is considered a positive scratch collapse test.	Brief temporary loss of the patient's external resistance tone is considered a positive scratch collapse test	Cheng, 2008[13]

Phalen's combined with sensory testing	Combines the traditional Phalen's test with simultaneous objective sensory examination of the hand with a standard monofilament (2.83) that is applied perpendicular to the skin's surface until it bends.	Considered positive if the subject did not register the touch in any one or more digits in a median nerve distribution (radial three and a half digits on the palmar side)	Bilkis, 2011[36]
Ratio of thumb abduction strength to index finger flexion strength	The strength of thumb abduction and index finger flexion was measured with a load cell mounted on a custom-made device.	N/A	Agabegi, 2010[42]
Wrist musculoskeletal pathology testing			
Scaphoid shift for scaphoid lunate instability	Pressure applied by examiner's thumb to the scaphoid tubercle. The wrist is axially loaded at the metacarpals and ulnarly deviated.	Reproduction of pain with or without hypermobility compared to the contralateral side	Wolfe, 1994[18]
DRUJ for DRUJ pathology	Gliding the ulna to its maximum dorsal and volar positions in neutral, supination, and pronation.	Reproduction of pain with or without hypermobility compared to the contralateral side	Prosser, 2011[20]
Midcarpal for arcuate ligament	Examiner positions his thumb over the dorsal distal capitate region of the patient's wrist. He then exerts a palmarly directed force onto the subject's wrist, allowing the carpus to translate palmarly. The wrist is then ulnary deviated while maintaining palmarly directed pressure.	Reproduction of pain with or without hypermobility compared to the contralateral side and "catch-up" clunk in the midcarpal joint	Prosser, 2011[20]
ECU synergy for ECU tendinitis	Patient rests arm on table with the elbow flexed 90° and the forearm in full supination. The wrist is held in neutral position with the fingers in full extension. Facing the patient, the examiner grasps the patient's thumb and long finger with one hand and palpates the ECU tendon with the other hand.	Re-creation of pain along the dorsal ulnar aspect of the wrist is considered to be a positive test for ECU tendonitis	Rutland, 2008[29]
CMC grind for CMC OA	The grind test is performed by gripping the patient's metacarpal bone of the thumb and moving it in a circle and loading it with gentle axial forces.	A patient with thumb joint arthritis generally complains of a sudden sharp pain at the CMC joint	Merritt, 2010[25]
Series of 3 tests for peritriquetral injuries	1) The maneuver is initiated by placing the wrist into full dorsiflexion and RD with the forearm in full pronation. Examiner pushes with the thumb pulp directly against the palmar surface of the patient's pisiform, while the fingers provide counterpressure on the dorsum of the ulna. As the pressure on the pisiform continues, the patient's wrist is brought into a neutral position, reducing the triquetrum. 2) The patient's wrist is placed in pronation, RD and neutral flexion. Examiner then places the opposite thumb pulp on the dorsal aspect of the triquetrum and presses the thumb in a palmar direction, the wrist is brought into UD. 3) This is the reverse of the second test, but is carried out with the examiner's thumb positioned over the pisiform and pushing the triquetrum dorsally. The pain on UD deviation will be reduced.	Positive test produces complaint of significant pain	Christodoulou, 1999[28]
Press test for testing DRUJ	Seated patient grips on both sides of the chair. The patient pushes body weight up from chair using the affected wrist.	Focal ulnar wrist pain replicating the discomfort that prompted patient to seek medical attention	Lester, 1995[26]
Ulnar fovea for detecting foveal disruptions and/or arcuate ligament	The ulnar fovea sign test is executed by pressing the examiner's thumb distally into the interval between the ulnar styloid process and flexor carpi ulnaris tendon, between the volar surface of the ulnar head and the pisiform.	Positive ulnar fovea sign is designated when there is exquisite tenderness that the patient claims replicates their pain, with comparisons made with the contralateral side	Tay, 2007[27]
Ulnomenisco-triquetral dorsal glide for TFCC	The patient is seated or supine with the elbow resting on the tabletop with the forearm in a neutral vertical position. The examiner's opposite thumb is positioned dorsally over the head of the distal ulnar and the radial side of the index PIP joint is placed over the palmar surface of the pisotriquetral complex. The examiner squeezes the thumb and the index finger together to produce a dorsal glide of the pisotriquetral complex on the distal ulnar head.	Reproduction of the patient's painful symptoms and/or excessive laxity in the ulnomeniscotriquetral region	LaStayo, 1995[21]
Ballottement for lunotriquetal joint	The examiner stabilizes the patient's lunate bone between the thumb and the index finger of one hand while simultaneously moving the pisotriquetral complex up and down on the lunate.	If pain is produced with palpation over the lunotriquetral joint, crepitus is caused at the lunotriquetral joint, or excessive laxity of the joint is revealed	LaStayo, 1995[21]
Lunotriquetral "shuck" (Kleinman's test) for lunotriquetal joint	The examiner stabilizes the patient's lunate bone between the thumb and the index finger of one hand while simultaneously moving the pisotriquetral complex up and down on the lunate with simultaneous passive deviation of the wrist.	Reproduction of the patient's pain	Prosser, 2011[20]

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Test	Technique	Positive test	Author, year
GRIT for ulnar impaction	3 grip measurements performed in neutral, supination, & pronation. A GRIT value is calculated by dividing the supinated grip strength by the pronated grip strength.	A GRIT of greater than 1.0 is considered positive	Prosser, 2011[20]
Ulnocarpal stress test for ulnar carpal instability	Examiner supports elbow of affected wrist in his hand. The examiner's other hand grasps the affected hand around the dorsum of the hand and ulnarly deviates the wrist. The examiner compresses the patient's arm and passively supinates and pronates the forearm.	Ulnar wrist pain occurring during forearm rotation constituted a positive test	Nakamura, 1997[37]
Finkelstein's test for DeQuervain's	Patient places their thumb within the hand and hold it tightly with the other fingers and then bend the wrist severely into ulnar deviation.	Intense pain is experienced on the styloid process of the radius where the tendon sheath takes its course	Finkelstein, 1930[2]
Scaphoid shear test for scaphoid instability	The examiner to grasp the scaphoid between their thumb and fingers and translate it dorsally, palmarly and ulnarward.	If excessive mobility is present and patient's pain is reproduced	International Wrist Investigator's workshop, 1992[43]
Piano key test for instability of DRUJ	Examiner exerts volarly directed pressure over the ulna. When this pressure is removed, the ulna returns back to its original position.	If this occurs, and it is associated with pain, crepitus and or snapping	Beckenbaugh, 1984[44]
Elbow			
Neuropathology testing			
Tinel for cubital tunnel syndrome	The examiner taps lightly at the ulnar nerve around the medial epicondylar groove.	Test is positive if the patient reports tingling or electrical sensations radiating to the fourth and fifth digits	Beekman, 2009[22]
Elbow flexion for cubital tunnel syndrome	With the participant sitting, the glenohumeral joint in a neutral position, the elbow in maximum flexion, the forearm in supination, and the wrist in neutral. This position was actively sustained for 60 s to 3 min depending upon author.	Positive outcome was indicated by either participant-reported paresthesias or worsening of preexisting paresthesias in the ulnar nerve distribution	Ochi, 2011[23]
Crossed finger test for cubital tunnel syndrome	The participant sits with forearms in pronation. The examiner instructed the participant to cross the middle finger over index finger of both hands.	A positive outcome was recorded if the participant could not fully cross the fingers on the involved side	Earle, 1980[31]
Shoulder IR for cubital tunnel syndrome	The patient's upper extremity was kept at 90° abduction, maximum internal rotation, and 10° flexion at the shoulder, with 90° elbow flexion and neutral position of the forearm and wrist, with finger extension.	Test results were considered positive if any slight symptom attributable to CubTS occurred within 10 s	Ochi, 2011[23]
Scratch collapse for cubital tunnel syndrome	Patient facing the examiner, with arms adducted, elbows flexed, and both hands outstretched with wrists at neutral position. The patient was asked to perform simultaneous resisted bilateral shoulder external rotation, keeping the arms abducted. The examiner gently pushed against both of the patient's forearms, asking him or her to sustain steady resistance. With fingertips, the examiner then scratched or swiped the skin overlying the course of the potentially compressed nerve. The ulnar nerve was scratched over the cubital tunnel at the medial elbow.	Positive scratch collapse test was recorded for the ulnar nerve if the patient demonstrated a momentary loss of external resistance tone on the affected side after "scratching" over the cubital tunnel	Cheng, 2008[13]
Ulnar nerve thickening for cubital tunnel syndrome	The examiner palpates the ulnar nerve around the elbow.	Examiner decides whether the ulnar nerve is thickened	Beekman, 2009[22]
Ulnar nerve tenderness for cubital tunnel syndrome	The examiner palpates the ulnar nerve around the elbow.	Examiner asks the patient if there is tenderness in the area, a positive response is a positive test	Beekman, 2009[22]
Resisted middle finger extension test for radial tunnel syndrome	Resist middle finger extension with elbow placed in full extension, forearm pronation and neutral wrist.	Reproducible pain over the ECRB, BR or course of radial nerve	Stanley, 2006[45]
Rule-of-Nine test	A large square box is drawn over the anterior aspect of the proximal forearm, it is then subdivided into 9 smaller, equal squares.	Pressure over the 2 most proximal lateral boxes overlying the supinator muscle and the radial nerve is thought to be diagnostic of radial tunnel syndrome	Loh, 2004[46]
Pronator teres syndrome test for compression of median nerve at pronator teres	Patient in sitting with elbow flexed 90°. Examiner places one hand stabilizing the elbow and the other proximal to the wrist. Examiner resists forearm pronation and elbow extension simultaneously.	Tingling or paresthesia within the median nerve distribution	Hartz, 1981[47]
Elbow musculoskeletal pathology tests			
Moving valgus stress test to test medial collateral ligament	Examiner applies and maintains a constant moderate valgus torque to the fully flexed elbow and then quickly extends the elbow.	Medial elbow pain is reproduced at the MCL and is at maximum between 120 and 70°	O'Driscoll, 2005[30]

Pivot shift test for posterolateral instability of elbow	Patient is supine, flex shoulder to 90° with forearm supinated. Valgus force is applied to elbow as it is being flexed.	Elbow will subluxate at about 40° of flexion and additional flexion will cause a reduction (visible clunk)	Regan, 2006[38]
Chair sign for posterolateral instability of elbow	Patient is in a seated position with elbows flexed 90°, forearms supinated, and arms abducted to greater than shoulder width.	Apprehension or dislocation occurs on terminal extension of arm from flexed position	Regan, 2006[38]
Push-up sign for posterolateral instability of elbow	Upper extremities are positioned with elbow at 90° flexion, with forearms supinated and arms abducted to greater than shoulder width.	Apprehension or dislocation occurs on terminal extension of arm from flexed position	Regan, 2006[38]
Table top relocation test for posterolateral instability	The patient is asked to stand in front of a table. The hand of the symptomatic arm is placed over the lateral edge of the table. The test involves 3 parts. The patient is initially asked to perform a press-up maneuver with the elbow pointing laterally. This maintains the forearm in supination. Pressure is pushed down through the hand onto the table, as the elbow is allowed to flex (bringing the chest toward the table). The maneuver is then repeated but with the examiner placing his or her thumb over the radial head, giving support and preventing posterior subluxation, while the press-up maneuver is performed.	In the presence of posterolateral rotatory instability, positive apprehension and a reproduction of pain occur as the elbow reaches approximately 40° of flexion	Arvind, 2006[39]
Varus stress for lateral collateral ligament	Elbow flexed at 25°, hold distal forearm with one hand, stabilize distal humerus, apply medial force to stress LCL.	Pain & instability	Morrey, 1996[48]
Valgus stress for medial collateral ligament	Elbow flexed at 25°, hold distal forearm with one hand, stabilize distal humerus, apply lateral force to stress MCL.	Pain & instability	Callaway, 1997[49]
Milking maneuver for medial collateral ligament	The humerus is extended and externally rotated to neutralize glenohumeral motion. The forearm is then supinated and a valgus stress is applied to the elbow by extending the thumb with the elbow flexed at 90°. The MCL is then palpated along its course.	Apprehension or reproduction of pain or symptoms along the course of the medial collateral ligament complex especially in between 30° and 60° of flexion	Cain, 2004[50]
Maudsley's test for lateral epicondylitis	The patients forearm and hand are positioned on a flat surface. The elbow is extended and the patient is asked to extend their middle finger. The examiner provides pressure over the extended digit.	Pain over lateral epicondyle region	Roles, 1972[51]
Mill's test for lateral epicondylitis	The patient seated and the upper arm is in a neutral position, while the elbow is flexed at 90° and the forearm is parallel to the floor in pronation. The elbow is supported with one hand while the other flexes the patient's wrist.	Pain at the lateral epicondyle	Mills, 1928[3]
Cozen's test	Patient makes a fist, elbow is supported with one hand (thumb over lateral epicondyle), and the patient is asked to extend the wrist against resistance while the forearm is pronated and the hand is radially deviated.	Pain over lateral epicondyle region	MacDermid, 2006[52]

N/A = not applicable; DRUJ = distal radioulnar joint; ECU = extensor carpi ulnaris; CMC = carpometacarpal; OA = osteoarthritis; RD = radial deviation; UD = ulnar deviation; TFCC = triangular fibrocartilage complex; PIP = proximal interphalangeal; GRIT = gripping rotatory impaction test; MCL = medial collateral ligament; CubTS = cubital tunnel syndrome; IR = internal rotation.
Highly recommended provocative tests: Shaded darkly.
Recommended provocative tests: Shaded light gray.
Neutral/no decision provocative tests: Are not shaded.