

Are Relieving Maneuvers Useful in Diagnosis of Carpal Tunnel Syndrome?

Rahatlatıcı Manevralar Karpal Tünel Sendromu Tanısında Yararlı mı?

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Abstract

Objective: Our aim was to assess and compare the diagnostic accuracy of the carpal tunnel syndrome relief maneuver (CTS-RM) and the Flick sign for the diagnosis of carpal tunnel syndrome (CTS) in female patients.

Materials and Methods: This is a diagnostic test study with blind comparison to a reference criterion. A total of 87 consecutive female patients with typical symptoms for CTS referred for electro-physiological examination were included in the study. Normal limits of nerve conduction were obtained from 50 healthy female subjects. After the electrodiagnostic assessment clinical evaluation was performed by a physician and it included testing of all patients for the CTS-RM and Flick sign. The diagnostic accuracy was evaluated for each test alone and in combination and sensitivity was correlated with the electrophysiological severity of CTS. Main outcome measures included the estimates of sensitivity, specificity, positive and negative likelihood ratios (PLR, NLR).

Results: After electrophysiological assessment, 58 patients (pre-test probability, 67%) have been diagnosed as CTS. The sensitivity and specificity estimates were %81,86 for the CTS-RM and %69, 79 for the Flick maneuver. Combining a positive CTS-RM and Flick sign improved the specificity to 93%. The PLRs of the CTS-RM and Flick sign were 3.3 and 5.9 and the NLRs were 0.39 and 0.22 respectively. Combining a positive CTS-RM and Flick sign had the PLR of 9.5 and the NLR of 0.37. When evaluating the subjects with CTS, the CTS-RM detected significantly more subjects compared to the Flick sign.

Conclusions: Our study reveals that the accuracy of Flick sign is low in the diagnosis of CTS. While the CTS-RM alone is helpful in confirming the diagnosis in patients with typical symptoms, combination with the Flick sign further improves its predictive accuracy.

(*Rheumatism 2008; 23: 129-34*)

Key words: Carpal tunnel syndrome, diagnostic testing, maneuver, likelihood ratio

Received: 21.09.2008

Accepted: 11.11.2008

Özet

Amaç: Amacımız kadın hastalarda karpal tünel sendromu (KTS) tanısında, rahatlatıcı manevra (KTS-RM) ve Flick belirtisinin tanısal değerini ortaya koymaktır.

Yöntem ve Gereçler: Bu araştırma diyagnostik bir çalışma niteliğindedir. Tipik KTS semptomları olan ve elektrofizyolojik inceleme için sevk edilen 87 ardışık kadın hasta çalışmaya dahil edildi. Normal sinir iletim değerleri için 50 sağlıklı kadında ölçüm yapıldı. Elektrodyagnostik incelemeyi takiben aynı hekim tarafından tüm hastalara KTS-RM ve Flick belirtisini içerecek şekilde klinik muayene yapıldı. Testlerin tek başına ve kombine olarak tanısal doğrulukları değerlendirildi. Testlerin duyarlılığı ile elektrofizyolojik KTS şiddeti arasında ilişki düzeyine bakıldı. Ana sonuç parametreleri olarak duyarlılık, özgüllük, pozitif ve negatif olabilirlik oranları (PLR, NLR) kullanıldı.

Bulgular: Elektrofizyolojik değerlendirme sonucunda 58 hastada KTS tanısı konuldu (ön-olasılık, %67). KTS-RM ve Flick manevraları için duyarlılık ve özgüllük oranları sırasıyla %81-86 ve %69-79 olarak bulundu. KTS-RM ve Flick belirtisinin aynı anda pozitif olması durumunda, özgüllük oranının %93'e yükseldiği görüldü. KTS-RM ve Flick manevraları için PLR oranları 3.3 ve 5.9, NLR oranları ise .39 ve .22 olarak bulundu. KTS-RM ve Flick belirtisinin aynı anda pozitif olması durumunda, PLR oranı 9.5, NLR oranı 0.37 olarak hesaplandı. KTS tanısı konulan denekler değerlendirildiğinde, KTS-RM'nin Flick manevrasına göre anlamlı oranda daha fazla KTS saptayabildiği görüldü. Elektrodyagnostik açıdan hastalığın şiddeti arttıkça manevraların duyarlılığının artma eğiliminde olduğu görüldü.

Sonuç: Bu çalışma Flick belirtisinin KTS tanısını koymada yetersiz olduğunu göstermektedir. KTS-RM, tipik semptomları olan hastalarda KTS tanısını doğrulamak için tek başına yeterlidir. Flick belirtisi ile beraber ele alındığında doğrulama gücü daha da artmaktadır.

(*Romatizma 2008; 23: 129-34*)

Anahtar sözcükler: Karpal tünel sendromu, tanısal test, manevra, olabilirlik oranı

Alındığı Tarih: 21.09.2008

Kabul Tarihi: 11.11.2008

Introduction

Carpal tunnel syndrome (CTS) is the most common nerve compression disorder of the upper extremity. According to population-based studies, about 3% of adults have electrodiagnostically confirmed CTS and women are affected 3 times more than men (1). While clinicians use electrodiagnosis frequently to confirm the diagnosis of CTS and some third-party payers require it before compensating claims, there has been a growing interest in developing a useful predictive diagnostic test based solely on physical examination.

Various clinical tests that rely on provoking the symptoms have been proposed for the evaluation of patients suspected to have CTS and some of them have become a part of the routine investigative procedure (e.g. Phalen, tinnel). However, clinical tests based on relieving the symptoms are limited. Among these is the carpal tunnel syndrome relief maneuver (CTS-RM), a new technique developed by Manente et al. (2). In an attempt to develop a provocative test by squeezing the distal heads of the metacarpal bones together, they observed relief of symptoms serendipitously. Because of its high sensitivity and specificity, they suggested the CTS-RM to be a useful test in confirming the diagnosis of CTS in patients with positive symptoms. However, the diagnostic importance of this potentially useful maneuver has not been validated by other studies.

Another maneuver that relieves patients' symptoms is the flicking motion of the hands and wrist called The Flick sign. Typically, patients flick their affected hand at times when symptoms are at their worst especially during sleep. Clinicians frequently look for this sign as part of their clinical evaluation before referring to electrodiagnostic evaluation. In this sense, the Flick sign may be considered as a clinical information based on the patient's medical history rather than a true clinical test based on physical examination like Phalen or 2-point discrimination (3). In some studies it was also utilized as a bedside evaluation tool in which patients are asked what they do with the affected hand at times when symptoms are at their worst (4). Although, the Flick sign is seen frequently in patients with CTS, it has not been well studied and its clinical utility has been limited due to the varying estimates of diagnostic accuracy in previous studies (4-8).

The aim of this study was to evaluate and compare the diagnostic accuracy of the CTS-RM and the Flick sign in diagnosis of carpal tunnel syndrome in female patients. The secondary purpose of this study was to examine the effects of disease severity and combination of maneuvers on diagnostic accuracy.

Materials and Methods

Data were collected from 100 consecutive female subjects with complaints of paresthesia, numbness and pain in

hands consistent with CTS who were referred to electrodiagnostic evaluation. 13 patients with systemic etiological factors including diabetes mellitus, connective tissue diseases, kidney and thyroid diseases, peripheral neuropathy or with onset of symptoms after trauma were excluded from the study. To avoid the effects of dependence between hands, only the involved side was selected in unilateral cases. In cases of bilateral involvement, the more affected side was chosen based on patient's symptoms. A total of 87 patients were included in the study.

Nerve Conduction Studies

Electrodiagnostic studies were performed with DISA Nueromatic 2000C ENMG device according to a protocol (9) inspired by the recommendations of the American Association of Electrodiagnostic Medicine (10). Normal values of nerve conduction tests were obtained from 50 asymptomatic healthy female volunteers. Median sensory conduction velocity was measured antidromically by a ring electrode on the 2nd digit (normal: ≥ 47.5 m/s). Median distal motor latency (DML) was measured with a surface electrode placed on abductor pollicis brevis muscle (normal: ≤ 4.0 ms). When these studies are normal, median-to-ulnar latency difference was calculated by stimulating the ring finger (normal: ≤ 0.5 ms) (11). If abnormalities were observed in the median and ulnar nerves of the same limb, other limb and one lower limb were examined to rule out a generalized polyneuropathy. Electrophysiological evaluation was normal in all control subjects. Patients diagnosed as CTS were divided into three groups using an arbitrary scale according to the values of DML; 1) 4.1-4.4 ms (mild), 2) 4.5-5.0 ms (moderate), 3) ≥ 5.1 ms (severe).

Clinical Evaluation

After the electrodiagnostic assessment, all patients were examined by a physician who was blind to the results of nerve conduction study. Physical evaluation included testing of all patients for the CTS-RM and Flick sign. Testing was performed in random order since it might be possible that they may have a cumulative effect that increases positive results for the test that is performed last.

Flick sign was elicited by asking the patients what they do with the affected hand at times when symptoms are at their worst. If the patient showed a flicking motion of the hands and wrists, the maneuver is considered to be positive.

The CTS-RM was performed as prescribed by Manente et al. (2). The affected hand was maintained with palm up and the distal heads of metacarpal bones (excluded first) were gently squeezed inducing a slight adduction of digits II and V. When this was not sufficient to relieve symptoms, palm was turned down and the digits III and IV were stretched simultaneously. Patients were blinded to the possible effects of the maneuvers and asked to indicate whether the maneuver: (1) abolished; (2) improved; (3) worsened; or (4)

did not change their symptoms. Results were dicotomized in such a way that either an improvement or abolishment of symptoms was considered as positive.

Statistical Analysis

Main outcome measures included the estimates of sensitivity, specificity, positive and negative likelihood ratios (PLR, NLR). The likelihood ratios (LRs) incorporate both the sensitivity and specificity and provide a direct estimate of how much a test result (positive or negative) will change the odds of having a disease. The diagnostic accuracy of any maneuver is considered useful if the PLR is 2.0 (to rule in disease) or greater or if the NLR is 0.50 or less (to rule out disease) (12). Since the prevalence (pre-test probability) in our study (67%) was different from the true prevalence of CTS in the population, likelihood ratios were weighted for prevalence according to the Bayes' Theorem ($Odds_{post} = odds_{pre} \times \text{likelihood ratio}$) to calculate post-test probabilities. Posterior probabilities were then compared with the prior probability. According to Jaeschke et al., LRs of 2 to 5 and 0.5 to 0.2 would generate small shifts, LRs of 5 to 10 and 0.1 to 0.2 would generate moderate shifts, and LRs greater than 10 or less than 0.1 would generate large and often conclusive shifts from pre-test to post-test probability (13). We also determined the diagnostic utility of combining the maneuvers.

It's been known that the precision of the estimates of diagnostic accuracy varies as a function of both the point estimate itself and the sample size. Hence, to enhance the clinical usefulness of information on estimates, the corresponding 95% confidence intervals were calculated for the all outcome measures according to the efficient-score method (corrected for continuity) described by Robert Newcombe (14). As LRs of 1 are diagnostically indeterminate, a clinical test is considered useful only if the 95% confidence interval (CI) about its LRs excludes 1. McNemar χ^2 results were used to evaluate if one maneuver identified significantly more subjects with CTS than the other. Measurement of agreement was evaluated by using Cohen's Kappa.

Results

The mean age of patients was 48.9 years (range, 23-72 years) and the mean duration of symptoms was 29.7 months (range, 1-140 months). The mean age of subjects in the control group was 47.3 years (range, 19-80 years). 58 of 87 patients had electrodiagnostic evidence of CTS. Hence, the pre-test probability of CTS in our study population was 67%. The CTS-RM was positive in 60% of patients. The basic maneuver was effective in 85% of patients, whereas stretching of digits III and IV was also required to induce improvement in the remaining 15%. The Flick sign was positive in 53% of patients (Table 1).

The sensitivity estimates of the CTS-RM and Flick sign were 81% and 69% and the specificity estimates were 86% and 79% respectively in our population (Table 2). Combining a positive CTS-RM and Flick sign improved the specificity to 93% at the expense of the sensitivity (66%). When evaluating the subjects with CTS, the CTS-RM detected significantly more subjects compared with the Flick sign (McNemar $\chi^2 = 4.5$, with $p = 0.03$). We found a moderate agreement between them (Kappa=0.50 CI, 0.26-0.75). The positive LRs of the CTS-RM and Flick sign were 3.3 and 5.9 and the negative LRs were 0.39 and 0.22 respectively. Combining a positive CTS-RM and Flick sign had the PLR of 9.5 and the NLR of 0.37. With increasing electrodiagnostic severity, the sensitivity of the two maneuvers showed a consistently increasing trend.

Discussion

Our study shows that under the conditions where the pre-test probability of CTS is intermediate or high, the accuracy of Flick sign is low in the diagnosis of CTS. The CTS-RM alone is helpful in confirming the diagnosis in female patients with typical symptoms and combination with the Flick sign further improves its prediction.

The majority of studies on the accuracy of clinical tests in the diagnosis of CTS were based on provoking symptoms

Table 1. Results of the clinical evaluation according to disease severity

Results of evaluation	Neurophysiological classification of CTS				
	All (n=58)	Mild (n=40)	Moderate (n=2)	Severe (n=6)	Negative (n=29)
Flick maneuver					
Observed	40	23	10	6	6
Not observed	18	17	2	0	23
CTS-RM					
Symptoms abolished	4	4	0	0	0
Symptoms improved	43	25	11	6	5
Symptoms worsened	0	0	0	0	0
No change	11	11	1	0	24

Table 2. Validity of clinical maneuvers with corresponding 95% confidence intervals (CI)

Maneuver (+/-)	CTS (+)* (n=58)	CTS (-)* (n=29)	Sensitivity %,CI	Specificity %,CI	PLR CI	NLR CI	Posterior probability % M+ % M-
Flick sign	40/18	6/23	69, 55-80	79, 60-91	3.3, 1.6-6.9	0.39, 0.26-0.58	87 44
CTS-RM	47/11	4/25	81, 68-89	86, 67-95	5.9, 2.3-14.7	0.22, 0.13-0.38	92 31
CTS-RM and Flick sign	38/20	2/27	66, 52-77	93, 76-99	9.5, 2.5-36.7	0.37, 0.26-0.53	95 43

* Maneuver (+/-)
M+/M- = posterior probability of a positive/negative maneuver
Prior probability is 67%

and reported inconsistent results (3, 15-18). However, recently a new clinical test (CTS-RM) has been developed by Manente et al. which relies on the relief of symptoms (2). They found it to be highly sensitive and specific for CTS and suggested its use for confirming the diagnosis only in patients with positive symptoms at the time of examination. Although, the estimates of sensitivity (81%) and specificity (%86) in our study population were fairly high, they are not comparable with their results. The rates of improvement were similar, whereas the rate of complete abolition was much lower (7%) in our study. While they observed a positive response in all patients, the CTS-RM did not change symptoms in 19% of our patients (2). Furthermore, there were notable differences in the mean age and sex distribution between the study samples. These discrepancies as well as differences in control groups, definition of CTS and disease severity make the comparison of the results difficult.

Although widely used, sensitivity and specificity have some deficiencies in clinical use. They are usually not helpful to clinicians trying to revise the probability of disease at the individual level since they are population measures summarising the characteristics of a test over a population (19). However, likelihood ratios are independent of disease prevalence and can be used directly at the individual patient level allowing clinician to quantitate the probability of disease (13). The pre-test probability was 67% in our study population. i.e. 67% of patients could be expected to have CTS before any evaluation. Given that the PLR of CTS-RM was 5.9, we might expect a moderate increase in the likelihood of CTS (13). This indicates a post-test probability of 92%. i.e. the patient has an 92% chance of having CTS given the positive result. On the other hand, a NLR value of 0.22 was expected to cause a small shift in pre-probability. i.e. the patient still has a 31% chance of having CTS despite the negative result. These findings suggest that the CTS-RM can be more helpful in confirming the diagnosis of CTS rather than ruling out in female patients with typical symptoms.

The Flick sign is frequently observed in patients with CTS and has been investigated in several studies (Table 3). However, it should be emphasized that the estimates of sensitivity and specificity for the Flick sign show a substantial variability between those studies. This may be related

to clinical, methodological and sampling factors including referral bias, spectrum bias, low sample size, different diagnostic criteria of CTS and different characteristics of control subjects. According to Irwig et al. (20), based on the variation in different study populations, one can know how the test will perform in various clinical settings. Pryse-Phillips's study provided the most promising results for the Flick sign (5). The high sensitivity and specificity demonstrated in this report were not confirmed by other authors and they reported the diagnostic accuracy of the Flick sign to be low with no clinical utility (3, 4, 6, 7). Nevertheless, in a recent study by Wainner et al.(8), the Flick sign had a fairly high sensitivity based on the medical history. Although, the estimates of sensitivity and specificity in our study population were higher compared to previous studies, they do not provide enough discriminative power for confirming or ruling out the diagnosis of CTS.

Given that the PLR of the Flick maneuver were 3.3, the post-test probability of CTS was only 87% in our study population. i.e. the patient has 87% chance of having CTS given the positive result. On the other hand, with the NLR of 0.22 the patient has still 44% chance of having CTS despite the negative result. These results suggest that the Flick sign cannot provide enough diagnostic accuracy either in ruling in or ruling out the diagnosis of CTS. Similarly, Hansen et al. (4), reported the diagnostic accuracy of the Flick sign to be low, based on very little changes in the pre-test probabilities either with a positive or negative result. They calculated predictive values instead of LRs. Yet again, the values of PLR (1.4) and NLR (0.85) calculated from their clinical data were in the inconclusive range suggesting a low diagnostic accuracy.

We investigated the question of whether the combination of the tests might be more powerful than a single test in establishing the diagnosis. Combining a positive CTS-RM with a positive Flick sign improved the specificity (93%) and the PLR (9.5) considerably at the expense of sensitivity. This indicates a post-test probability of 95%. i.e. the patient has 95% chance of having CTS given the positive result for both maneuvers. Thus, it can be more useful in confirming the diagnosis of CTS compared with the CTS-RM alone. Besides, the evaluation for the Flick sign is quick and operator-independent allowing an easy concurrent use with the CTS-RM.

Table 3. Results of the diagnostic accuracy for the Flick sign in different study populations

	Sensitivity	Specificity	PLR*	NLR*
Pryse Phillips ⁵	0.93	0.96	21.4	0.10
Roquer and Herraiz ⁶	0.36	-	-	-
Krendall et al. ⁷	0.25	0.61	0.6	1.23
De Krom et al. ³	0.50	0.61	1.3	0.82
Hansen et al. ⁴	0.37	0.74	1.4	0.85
Wainner et al. ⁸	0.81	0.57	1.9	0.34
Our results	0.69	0.79	3.3	0.39

PLR: Positive likelihood ratio

NLR: Negative likelihood ratio

* Calculated from the clinical data of those studies

According to Jaeschke et al. (13), when patients with a certain disorder all have severe disease, sensitivity for a test increases; if patients are mildly affected sensitivity decreases and LRs move toward a value of one. In accordance with this, we found a substantial and consistent increase in the sensitivity of maneuvers (especially CTS-RM) with increasing electrodiagnostic severity (Figure 1). Similarly, Hansen et al. (4) found an increasing trend in the sensitivity of Flick sign. In contradiction with these results, Mondelli et al. (18) found a decreasing trend in the sensitivity of Flick sign in advanced clinical and electrophysiological stages of disease. The discrepancy in these results can probably be explained by differences in study populations, study design, definition of CTS and disease severity. For example, in our study the disease severity was determined by the DML alone, while the other authors (2, 18) took both distal motor latency and sensory conduction velocity into account as well as clinical severity.

Several factors limit the generalizability of our results, including sample size, lack of a challenging control group, disease severity, reliability of the tests, and recruitment source. Our relatively small sample size resulted in wide

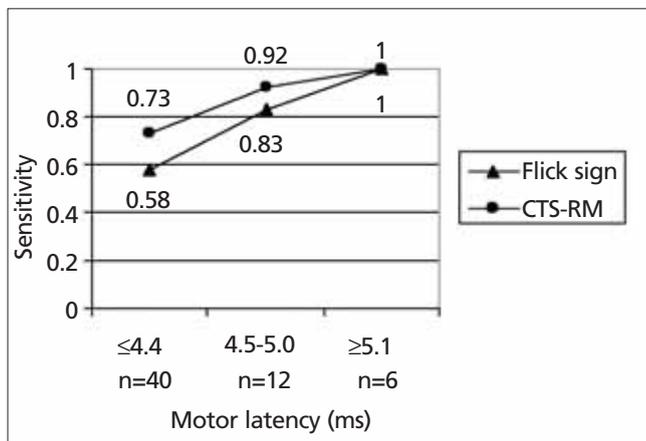


Figure 1. Sensitivity of the CTS-RM and Flick sign with prolonging motor latency values

95% CIs of our point-estimates. Therefore further validation of these results is needed in larger patient populations. The control group consisted of patients with typical symptoms for CTS who had normal electrophysiological findings. If it included the patients with symptomatic hand pathology other than CTS, then the estimate of specificity would have been lower with resultant changes in the point estimates of likelihood ratios. While some suggest use of a healthy, asymptomatic control group to assess true sensitivity and specificity, others emphasize use of symptomatic control group relevant with the disease in question.

Currently electrodiagnostic studies are the only truly objective ancillary test available for diagnosis of CTS. However, they are still not considered as an ideal gold standard. Since we used a set of electrodiagnostic criteria for diagnosis, the possibility that some of the patients in our control group might have had CTS remains unanswered. In so far as that is the case, our estimates of LRs could be incorrectly affected by this spectrum bias. Assessment of disease severity according to an arbitrary electrophysiological scale was another potential source of bias which might have influenced our results. It should be noted that there was an over-representation of mild disease (69%) in our study sample reflecting a spectrum bias. Therefore the point estimates of sensitivity obtained in our study actually would have been higher. For example, in neurology practice where study population would have more pronounced symptoms and more advanced disease the CTS-RM and the Flick sign would have higher estimates of sensitivity.

The reliability of clinical tests is a major concern in determining diagnostic accuracy. The Flick sign has usually been considered as a simple, operator-independent and reproducible test. It has been reported to have an excellent reliability (90%) in a recent study by Wainner et al (8). On the other hand, the CTS-RM may be considered as an operator-dependent clinical test. Although we did not observe any worsening by CTS-RM in our patients, the question of its test-retest reliability still remains unanswered and needs to be determined.

The predictive value of diagnostic tests is dependent on the prevalence of disease in the population being tested (pre-test probability). They are mostly valuable as complementary information to clinical assessment, particularly when pre-test probability of a disease is intermediate (i.e. between 20% and 80%) (20). According to Jaschke et al. (13), each item of history, or each finding on physical examination represents a diagnostic test that either increases or decreases the probability of a target disorder. Thus, the pre-test probability is likely to be lowest with screening tests and greatest with tests performed in referred patients (20). Since our study population was derived from symptomatic patients referred to electrodiagnostic assessment after a clinical evaluation by a physiatrist, the pre-test probability was fairly high. Therefore, our results are most applicable to female patients with severe enough symptoms to warrant such a referral in a secondary care setting such as neurology or physiatry where the pre-test probability of CTS is expected to be intermediate or high.

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