Improving Diagnostic Precision of Carpal Tunnel Syndrome with Assessment of Hand Functionality: A Clinical Series

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ABSTRACT

Carpal tunnel syndrome (CTS) is the most frequently reported cumulative trauma disorder that involves repetitive motion (NIOSH, 1997). Diagnosis of this injury to the flexor and/or median nerves is difficult to assess and is still fairly subjective when based on the patient's perception of pain and the patient's propensity to physically compensate for an injury. Accounting for 62% of all Workers' Compensation claims, the problems associated with CTS among US workers and the general population exact a huge toll in terms of health-related costs and lost in work productivity. An estimated cost of repetitive stress injury, such as CTS, annually due to disability and lost time ranges from $15 to $20 billion. CTS is a major public health and occupational health issue.

Conventional tests for CTS—Tinel's Sign, Phalen's Test, Semmes-Weinstein Test, and Durkan Compression Test—are not adequately sensitive or specific, and they do not directly assess functionality of the wrist and hand; yet, they are the standard clinical tests. Therefore, a significant proportion of CTS cases are misdiagnosed based on the results of these tests. For example, when multiple tests are administered, the number of false positives observed is increased up to 50%, very close to the failure rate cited by OSHA of 45% for carpal tunnel release surgery. Research data show that test results using these tests could result in a false positive rate as high as 48%. A more accurate test is needed to improve the precision of diagnosis of CTS and reduce the probability of unnecessary surgical treatments.

This study is a clinical series of three patients with bilateral CTS diagnosed by standard electrodiagnostic tests and a new noninvasive technique which employs *Sensokinetogram* (*SKG*^{SM}) *System*, based on a medical device approved by the FDA. Preoperative tests with the *SKG*^{SM} *System* demonstrated hand functionality results consistent with CTS. Serial postoperative tests on the patients after surgical treatment (2-portal endoscopic CTS release) showed changes in the *SKG*^{SM} characteristics that represented progression and recovery towards normal hand function.

The *SKG*^{SM} *System* employs rapid time dependent biomechanical measurements to monitor the neuro-musculo-skeletal system from the hands to the neck of the cases. This approach is a significant departure from the current clinical and electrodiagnostic instrumentation because the *SKG*^{SM} *System* measures hand functionality in a noninvasive, painless, objective manner.

By measuring the mechanical forces applied by the thumb (digit I), index (digit II) and small (digit V) fingers on three independent load cells, several parameters, such as *absolute* and *relative strength*, *independent fatigue rates* for all three applied forces, *applied timing jitter*, *correlation* and *cross-correlation factors*, can be directly measured from the sensors. From these measurements, *motor* and *senor rank scores* can be computed to determine the probability of CTS and the functional performance of the fingers and hand. The cumulative probability function generated for a *mean shifted score* ($x-\mu$) will form the basis for a comparative scale. This entire test requires a total of approximately five to ten minutes to

measure functionality in both hands. Furthermore, the measurement is independent of the tester and can be easily replicated.

The results of this clinical series highly suggest the *SKG^{SM} System* can be used as a better, more accurate diagnostic tool for CTS, as well as a convenient device to monitor the recovery of the hand and wrist after surgical treatment. Improved diagnostic accuracy and knowledge about the efficacy of surgical treatment based on hand functionality decrease misdiagnosis and unnecessary surgeries and increase the rate of recovery when the patient is closely monitored. The *SKG^{SM} System* can be applied to study the diagnoses of other hand/wrist disorders and conditions, such as Reynauld's disease, rheumatoid arthritis, Fibromyalgia, and diabetic neuropathy.