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The sensory function of the uninjured nerve in patients after median and ulnar nerve injury

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ABSTRACT

Study Design: A retrospective cohort study.
Introduction: Some patients after median or ulnar nerve injury report a diminished sensibility in the fingers that are supplied by the uninjured nerve.
Purpose of the Study: The purpose of this study was to evaluate the function of the uninjured nerve in patients after peripheral nerve injury to assess the presence and degree of its functional impairment.
Methods: There were 28 patients with median and 29 patients with ulnar nerve injury examined for sensory disturbances in the injured and uninjured nerves, using several tests assessing touch, temperature, and vibration sensibility.
Results: In 16 patients after ulnar and 13 patients after median nerve injury, some disturbances in the uninjured nerve were found, mostly in individual tests. Only 8 patients had 3 or more different tests abnormal.
Discussion: The injured nerve function in patients with functional disturbances in the uninjured nerve was worse than in patients with normal test results.
Conclusion: Posttraumatic changes in central nervous system are the possible reasons.
Level of Evidence: Level III study.

Introduction

Peripheral nerve injury is a devastating trauma that results in variable hand dysfunction, even with proper surgical treatment. The injured nerve almost never recovers to a preinjury functional level.[1-3] Together with a various degree of motor and sensory dysfunctions, the patients have a disturbed hand movement coordination, as well as a limited ability to recognize shapes, textures, and objects. This ability, described as tactile gnosis, is a vital part in our recognition of the outer world.[4]

The causes of a worse nerve function after injury can be broadly divided into peripheral and central. In the periphery, the regeneration of the axons that need to grow into the distal stump of the nerve sheath is imperfect. The sprouting axons can be blocked by intraneural scar that develops at the injury site. The axons may reach different receptors and effectors than they were previously innervating. Also, the receptors and effectors may become atrophic before the innervating axon reaches them.[2] In the central nervous system, the posttraumatic nerve cell apoptosis of the affected neurons in the spinal cord limits the number of regenerating axons and active nerve cells.[2,5] The neurons in central nervous system are functionally and anatomically connected, therefore, abnormal function or apoptosis of a neuron may negatively influence the function of a connected intact neuron. Possible other factors that can change nerve function even in areas remote to the injury site are inflammation, oxidative damage, and autophagy, as well as cortical remodeling of motor and sensory brain areas after trauma.[2,6]

This study is derived from a clinical observation that some patients after median or ulnar nerve injury report a diminished sensibility in the fingers that are supplied by the uninjured nerve. We assessed the ulnar nerve in patients after median nerve injury, and the median nerve after ulnar nerve injury, using standard and well-known assessment tools.[1,7-9] Two clinical measures seldom used after traumatic nerve lesions but used in neurologic or diabetes research, that is the vibration and temperature sensibility, were also incorporated.[10-12]

Purpose of the study

The purpose of this study was to evaluate the function of the uninjured nerve in patients after peripheral nerve injury to assess the presence and degree of its functional impairment.

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Methods

The documentation of all patients who sustained a penetrating injury in the forearm or wrist between years 2004 and 2010 was evaluated. All were initially operated on emergency duty in our department. Patients with a confirmed intraoperatively complete lesion of median or ulnar nerve were asked for a follow-up assessment. Exclusion criteria included partial nerve lesions, injuries to both median and ulnar nerves, and conditions that could influence nerve function (diabetes, alcohol abuse, or neurologic disorders).

There were 28 patients (22 males and 6 females) with median nerve injury and 29 patients (25 males and 4 females) with ulnar nerve injury examined. Mean age at the time of injury was 38 years (range, 15-59; standard deviation [SD], 14.1). Mean follow-up was 55 months (4.5 years), with a minimum of 9 months after surgery (range, 9-114 months; SD, 30.7).

All patients were invited for an additional follow-up examination, after completing the period of post-traumatic clinical evaluation and rehabilitation. They were examined by a single rater. A list of tests performed is presented herein.

1. Semmes-Weinstein monofilament test.
2. Static 2-point discrimination test.
3. Shape/texture identification test.
4. Thermal discrimination test.
5. Vibration assessment test.
   a. Vibratrom device.
   b. Rydell-Seiffer tuning fork.
6. Medical Research Council (MRC) power grading.
7. Disabilities of Arm, Shoulder and Hand (DASH) questionnaire.
8. Rosen and Lundborg assessment score.

Each test is thought to evaluate a different nerve function.

The Semmes-Weinstein monofilament test evaluates the amount of pressure that needs to be applied to stimulate touch receptors, static 2-point discrimination test evaluates the density of functioning touch receptors,[13] shape/texture identification test evaluates tactile gnosis,[4] thermal discrimination test assesses the ability to tell the difference in temperatures of 2 different objects, and vibration tests assess the ability to recognize vibration, however, of different frequencies and amplitudes in both tests,[10,11] and MRC power grading evaluates the motor function exclusively.[7]

For the uninjured median nerve, sensibility was evaluated on the pulp of the index finger and thumb. The thumb was assessed in the Semmes-Weinstein monofilament test and the static 2-point discrimination test only. For the uninjured ulnar nerve, the pulp of the Vth finger was evaluated.[9] The uninjured hand served as control. The temperature and vibration thresholds were evaluated on the index and Vth finger only.

The Semmes-Weinstein monofilament test is applied with a set of 5 monofilaments (2.83 = no. 1; 3.61 = no. 2; 4.31 = no. 3; 4.56 = no. 4; and 6.65 = no. 5), beginning with the 6.65 monofilament. Three random applications were used, and the monofilament scores positive when at least 1 application is perceived as touch by the patient. Sensibility is considered normal when the patient scores positive with the lightest (2.83 = no. 5).[8,12,14]

The static 2-point discrimination test[8] was performed using the Dellon discriminator, using 10 random applications on the pulp of the examined finger. The application should cause slight blanching of the skin around the ends of the discriminator rods. The threshold was determined when the patient recognizes 7 of 10 applications as 2 separate points of touch. The results are given in millimeters and then qualified to 1 of the following result scores: 0 = >15; 1 = 11-15; 2 = 6-10; and 3 = <6 mm.[8]

The shape/texture identification test was performed using discs manufactured according to the detailed description provided by Rosen and Lundborg. The patient was positioned behind a screen and asked to recognize sample shapes (cube, cylinder, and hexagon) and textures (1, 2, and 3 raised metal dots placed in rows) using index finger alone (assessment of median nerve) and Vth finger (assessment of ulnar nerve). The objects were exposed randomly, starting with the largest object. The uninjured hand was tested before the injured hand to allow patients to learn the correct testing procedure and exclude patients with possible impaired nerve function resulting from, for example, polyneuropathy. The uninjured nerve was tested before the injured nerve. Normal score is 3 points for shape recognition and 3 points for texture identification, giving a total score of 6 points, which is considered normal for an uninjured nerve, according to Rosen and Lundborg.[4]

The thermal discrimination test was performed with the Physitemp NTE-2 device (Physitemp Instruments Inc, 154 Huron Avenue, Clifton, NJ). It consists of 2 metal testing plates, the temperature of one is fixed and another whose temperature changes during testing. The test was performed after the patients adapted to the room temperature, which is approximately 22°C. The patient was instructed to place the tested finger on 1 of the metal testing plates for approximately 1 second and then move the finger to the second plate to tell which plate was cooler.

The temperature differences are set by the manufacturer as SDs from normal, established in different age groups. There are 6 possible levels of function for each age group (Table 1). One of the plates serve as control, with its temperature set for 25°C, and the temperature of the other is set to be cooler or warmer. The test is begun with temperature difference of 5 SDs between the 2 plates. If the patient recognizes the cooler plate correctly, the temperature difference is lowered one level down; if the answer is incorrect, the difference in plate temperatures is increased one level up. The level of temperature differentiation is established as the smallest plate temperature difference recognized correctly. The test is performed 3 times to exclude the element of chance, with at least 2 corresponding answers considered to be the final test result. If all 3 answer series were different, according to test specifications, the patient is supposed to be excluded from the evaluation. In our study, all patients completed the test correctly, and none was excluded from the study based on this test result.[15]

The vibration assessment with the Vibratrom NTE-2 device (Physitemp Instruments Inc, 154 Huron Avenue, Clifton, NJ). It consists of 2 vibrating rods, with one vibrating during testing and the other being still. The vibration magnitude is preset by the manufacturer, and it is changed during testing according to provided charts. The magnitude of vibration is preset by the examiner at 6.5 units, and the patient is asked to tell which of the rods is vibrating. If the patient answers correctly, the vibration magnitude is lowered at a rate of approximately 10%, and the test repeated; when the patient answers incorrectly, the magnitude is increased at about 10%. The examination is performed until 5 incorrect answers are obtained, or until 18 tests are performed. However, only 1 incorrect answer is allowed in the first 8 tests; in this case, the test is begun anew with higher initial vibration values. The analysis consists of 5 incorrect values and 5 lowest values, the highest and lowest scores are excluded, and the final score is the mean of the remaining 8 values. The range of values is established for 4 age groups, with 4 levels of possible dysfunction.[15] The results of patient's examination were classified to a dysfunction level in a numerical score, according to Table 2.

In addition, vibration threshold was assessed with Rydell-Seiffer tuning fork.[10,11] The tuning fork vibrates at a frequency of 64 Hz. On the prongs of the fork, there are 2 calibrated weights that allow scoring, with 2 triangles that intersect virtually while vibrating. The