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Nerve injuries to the volar aspect of the hand: A comparison of the reliability of the Weber static test *versus* the gauze test

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ABSTRACT

When examining lacerations to the volar aspect of the hand a gauze test may usually be performed to detect nerve injuries. However, published literature suggests that its sensitivity and specificity are lower than 100%. The aim of this study was to determine whether a Weber static (main hypothesis) and dynamic test or a Semmes-Weinstein test (secondary hypotheses) could be a more reliable test than the gauze test to rule out any nerve injury and avoid unnecessary wound explorations.

Our case series included a total of 102 patients presenting with 123 palmar lacerations and 158 nerve injuries. On arrival at the emergency department, every patient was tested for epicritic sensation at the pulp of the injured and contralateral fingers with the Weber static and dynamic tests and the Semmes-Weinstein monofilament test. All lacerations underwent exploration under anesthetic to rule out nerve injury.

The sensitivities of the gauze test, the Weber static test, the Weber dynamic test and the Semmes Weinstein monofilament test were proven to be 82.5%, 98.6%, 97.9% and 86.7% respectively. The specificities of the gauze test, the Weber static test, the Weber dynamic test and the Semmes Weinstein monofilament test were 79%, 79%, 79% and 78.9% respectively.

Examination of lacerations to the volar aspect of the hand to rule out any nerve injuries should include a Weber static test instead of a gauze test. A negative Weber static test should not however discourage a surgical exploration of the laceration to rule out tendinous or vascular injury.

Introduction

Failure to adequately diagnose nerve injuries in volar lacerations of the hand is a common occurrence [1,2]. Consequences of such a failure may lead to serious consequences including: altered sensation, neuroma, type I CRPS (complex regional pain syndrome) [3].

On examination of volar lacerations, sensation is usually tested with the gauze test. Sensitivity and specificity of this test are inferior to 100% [4] and most of the authors consider surgical exploration in every volar laceration located within the vicinity of the nerve [5]. This approach however may lead to unnecessary surgical explorations. The aim of this study is to verify whether a Weber static test could replace the gauze test in the assessment of volar lacerations of the hand.

The main hypothesis is that the Weber static test has higher sensitivity compared to the gauze test in the diagnosis of nerve injuries in volar lacerations of the hand. The secondary hypotheses are that the sensitivities and specificities of the Weber's static and dynamic test and of the Semmes-Weinstein test are higher than those recorded for the gauze test.

Materials and methods

All the patient's files who attended our hand trauma service for volar lacerations located within the vicinity of the nerve between November 2016 and March 2017 were reviewed. We excluded all patients younger than 18-year-old, pregnant women, wrist lacerations proximal to the carpal tunnel, complex wounds with multiple underlying injuries which needed surgical intervention, lacerations associated with crush injuries, wounds older than 24 h, patients with preexisting hand injuries, presenting altered nerve function or impaired cognitive function. We included in the study all patients presenting with injuries to the volar aspect of the hand

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along the course of the nerve in the area extending from the proximal border of the carpal tunnel to the palmar crease of the DIP joint. Our case series included 123 lacerations within in the vicinity of the course of 158 sensory nerves in 102 patients aged between18 and 86 years old. The mean age was 33 years old. The case series included 30 female patients and 72 male patients (Table 1). One hundred and forty eight lacerations were located distally and 10 lacerations were proximal to the bifurcation of the interdigital nerve.

On arrival at the emergency department, every patient was tested for epicritic sensation at the pulp of the injured and contralateral digits with 4 tests: the gauze test, the Weber static and dynamic tests and the Semmes-Weinstein monofilament tests.

The gauze test was performed by stroking each side of the finger pulp with dry gauze when the patient had his eyes closed. The test was considered positive when sensation on the injured and contralateral digit was the same and negative when a difference between the two sides was detected (paresthesia, dysesthesia, hypoesthesia, and anesthesia) [4].

The Weber static test was performed by measuring the two-points discrimination distance with a "Disk-criminator®" (Alimed™, Dedham, Massachussets, USA) applied perpendicularly on both hemipulps with constant gentle pressure without causing the skin to blanch. The test was considered negative when sensation was the same on both sides and positive when a difference of more than 2 mm was found [6].

The Weber dynamic test was performed by measuring the two-points discrimination distance by applying the "Disk-criminator®" (Alimed™, Dedham, Massachussets, USA) perpendicularly on both hemipulps with constant gentle pressure without causing the skin to blanch and moving it in a proximal to distal direction. The test was considered positive when sensation was found to be equivalent on both sides and negative when a difference of more than 2 mm was found [6].

The Semmes-Weinstein monofilament test is based on the measurement of the force of the finest monofilament perceived amongst a kit of 20 monofilaments ranging from 0.008 g to 300 g (Baseline Tactile Semmes-Weinstein Monofilament®, Patterson Medical™, Warrenville, Illinois, USA). The force is applied perpendicularly to the radial and ulnar hemipulps. The test was considered positive when sensation was the same on both hemipulps or a difference of less than 2 monofilaments was detected and negative if a difference of more than two monofilaments was detected.

When the injury was located distally to the trifurcation of the interdigital nerve, sensation was only tested on the side of the injury. When the injury lied proximal to the trifurcation of the interdigital nerve, both hemipulps where tested and if no difference was found between the injured and the contralateral side, only the results from one hemipulp were recorded and taken into account.

All wounds were explored under local or regional anesthesia and the type of the injury to the sensory nerve was noted. The intraoperative findings where noted in the patient's file for explorations carried out in the Emergency Department and in the operative record for those performed in the operating theatre. All partially or totally divided nerves were repaired under magnification. Intact, bruised nerves and epineural injuries were not repaired and considered as normal.

All data were processed in order to assess and compare the specificity and sensitivity of each clinical test (gauze test, Weber static test, Weber dynamic test and Semmes-Weinstein monofilament test) in detecting nerve injuries.

The statistical analysis of the data was performed by comparing the sensitivity and specificity of the gauze test to the specificity and sensitivity of each of the other three clinical tests (Weber static test, Weber dynamic test and Semmes-Weinstein monofilament test) in detecting nerve injuries.

Given our sample size, the old methods known as "frequentist statistics", expressed as p values, would have led to a low power. In this work, we used the Bayesian methods of data analysis, which consist in calculating the probability of observing a difference or not, leading to a greater power. This calculation makes it possible to obtain a probability between 0 and 1, more precise than a binary response $p < $ or $p > 0.05$. A probability of difference in credibility between the two groups of more than 90% corresponded to a large difference, more than 95% to a larger difference, and more than 97.5% to the equivalent of a significant difference. All analyzes were carried out using software R in version 3.2.2.

Table 1
A case series of 123 wounds within the vicinity of 158 sensitive nerves in 102 patients.

Age (years)		32.8 (18–86)
Gender	Men	72
	Women	30
Hand Dominance	Right	93
	Left	9
Affected side	Right	43
	Left	59
Affected digit	Thumb	27
	Index finger	39
	Middle finger	21
	Ring finger	15
	Little finger	20
Zone of injury	1	25
	2	78
	3	16
	4	4
Size of the wound (mm)		17.5 (5–40)

Results

The sensitivity of the gauze test was estimated as 82.5% with a confidence interval of 95% [75.9%; 88.3%]. The sensitivity of the Weber static test was estimated as 98.6% with a confidence interval of 95% [96.1%; 99.8%]. The probability of the sensitivity of the Weber static test being higher than the sensitivity of the gauze test was estimated as 100%, which represents a significant difference. The sensitivity of the Weber dynamic test was calculated as 97.9% with a confidence interval of 95% [95%; 99.6%]. The probability of the sensitivity of the Weber dynamic test being higher than the sensitivity of the gauze test was estimated as 100%, which represents a significant difference. The sensitivity of the Semmes-Weinstein monofilament test was 86.7% with a confidence interval of 95% [80.7%; 91.7%]. The probability of the sensitivity of the Semmes-Weinstein monofilament test being higher than the gauze test is 84% (Fig. 1).

The specificity of the gauze test was 79% with a confidence interval of 95% [58.6%; 93.7%]. The specificity of the Weber static test was 79% with a confidence interval of 95% [58.7%; 93.6%]. The probability of the specificity of the Weber static test being higher than the gauze test was 50%. The specificity of the Weber dynamic test was 79% with a confidence interval of 95% [58.6%; 93.6%]. The probability of the specificity of the Weber dynamic test being higher than the gauze test was 50%. The specificity of the Semmes-Weinstein monofilament test was 78.9% with a confidence interval

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