18 Feb 2025

“Sensory neurography and S2PD: A Test-Retest study”

Amendment to ethical approval

1.3 Briefly describe the planned amendment to the previously approved application

Before initiating the previously approved study, we plan to conduct a pilot study in the form of a test–retest investigation involving 10 research participants without any prior digital nerve injury. The purpose is to assess whether the method is reproducible without excessive variation in primary and secondary outcome measures.

The variation between measurements should not exceed 50%, as this is the threshold above which a nerve injury is suspected when comparing responses from two digital nerves in sensory nerve testing. Reference values for sensory neurography measurements of digital nerves have been obtained from the Department of Clinical Neurophysiology at Uppsala University Hospital (UAS) for comparison.

The examinations will be performed on two occasions, approximately two weeks apart. The fingers to be examined are the index finger, middle finger (radial and ulnar digital nerves), and ring finger (radial digital nerve), on both hands.

Participants will be examined using the same method described in the original application. The exclusion criteria will remain unchanged; however, the inclusion criterion will be modified in this study to *“no prior history of digital nerve injury”* instead of *“previous digital nerve injury.”* Potential participants will be recruited verbally among healthy individuals at the Department of Hand Surgery, Södersjukhuset.

The intraclass correlation coefficient (ICC) will be used to assess the reliability of the measurements.

1.3.1 Summary of the amendment

The amendment concerns an addition in the form of a test–retest study involving ten research participants.

1.4 State the reasons for the planned amendment

We aim to evaluate whether the measurement method to be used in the study is reproducible with respect to test–retest reliability.

1.5 Assessment of how the risk–benefit balance is affected by the amendment

Participants will not be exposed to any physical risks. They may experience some discomfort during the examination; however, this is temporary and not associated with any risk of lasting harm.

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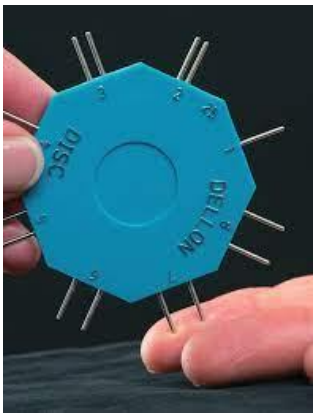
"Investigation of the correlation of sensory neurography findings and S2PD measurements after digital nerve injury"

Background:

There are several methods to assess sensation in the fingers after nerve injuries: S2PD (static two-point discrimination test, former Weber test), M2PD (moving 2PD), SMW (Semmes-Weinsteins monofilament test), and sensory ENeG (electroneurography). The most widely used test in orthopedic and hand surgery clinics is the S2PD.



Discriminator to measure S2PD

In this test two pins are pressed perpendicular and longitudinally on each side of the fingertip. The pins can consist of an unfolded paper clip or a factory-made discriminator. The distance between the two pins, where it is possible to discriminate between one or two pins, is the S2PD(1). Interobserver variability has been tested(2) with good results but its reliability is still questioned(3). There is no standardization of the technique used when examining patients with the discriminator, for example, how to put the right pressure on the pins and how to press the two pins on the skin simultaneously. The temperature of the fingertip, cognitive dysfunction and language difficulties may also affect the measurement results. There are different opinions on what you actually measure with the S2PD test, is it pressure, light touch, or is it vibration when the pins touch the skin?

When the function of a sensory nerve is investigated with a neurophysiological examination, an electric impulse is sent through the nerve, either in an orthodromic (distal stimulation, proximal registration) or antidromic (proximal stimulation, distal registration) fashion(4). The nerve is composed of thousands of nerve fibers that conduct the electrical signal through the nerve. Nerve action potentials propagate along all functioning axons as the membrane depolarize and repolarize. A digital nerve consists of both faster and slower axons. To depolarize both slow and fast fibers a stimulus 20% above the maximum action potential is used(5). The amplitude of the sensory nerve action potential is the sum of the action potentials of myelinated axons and is an estimate of the number of axons in the nerve. A more precise method to calculate the axons is to measure the area under the sensory nerve action potential curve. The area under the curve includes axons with low conduction velocity, while the amplitude might show false low values if nerves with lower myelinization are included.

Standardized instruments are important to be able to compare and evaluate sensory recovery(6) after injuries and interventions. If we can find a correlation between the most widely used assessment tool and the more exact but time and resource consuming neurophysiological examination, we can be more certain of what we are testing and the extent of the nerve injury.

Research question:

Are there measurable differences in neurophysiological examination findings in fingers after treatment for digital nerve injury that correlate to differences in the discriminative sensory ability experienced by the patient?

Design:

Cohort study.

Population:

60 patients, age > 20 years old at injury, < 60 years old at inclusion, treated surgically at the Hand Surgery Clinic at Södersjukhuset, for an isolated digital nerve injury in the second, third or radial side of the fourth finger, ≥1 year prior to inclusion, between 2013-2023. Patients will be identified in the HAKIR registry.

Inclusion criteria:

Age at injury >20-years, < 60 years old at inclusion, injury ≥1 year prior to inclusion, isolated digital nerve injury in finger II, III or radial side of finger IV, level of injury proximal or middle phalanx.

Exclusion criteria:

Neurological conditions, cognitive disabilities and dementia, diabetes, serious mental disorder, ongoing drug or alcohol abuse, previous traumatic experiences involving electrical stimulation/impulses, symptoms of carpal tunnel syndrome, difficulties understanding Swedish language.

Intervention:

Neurophysiological examination with antedrome and orthodrome stimulation (stimulation of the median nerve over the wrist and registration at the finger and vice versa) and S2PD of the injured finger.

Control:

Neurophysiological examination with antedrome and orthodrome stimulation (stimulation of the median nerve over the wrist and registration at the finger and vice versa) and S2PD of the same finger on the uninjured hand.

Assessments:

Gender, age, date of injury and operation, operative treatment, date of examination, age at injury, smoker or not, employment, length, dominant hand, injured hand, level of injury, temperature of examined fingers, injured finger, injured nerve, S2PD in mm in injured and contralateral uninjured finger, amplitude in µV, area in µVms, maximum intensity of stimulation in mA, distance between stimulating and registering electrodes in mm, velocity.

Outcomes:

Primary outcome:
Is there a correlation between amplitude and S2PD or between area and S2PD?

Secondary outcomes:
Do certain values of amplitude or area correspond to certain values of S2PD? How do other parameters such as gender, age, length and smoking affect the correlations?

Statistics:
Numerical values will be tested for normality by Shapiro Wilk's test. Normal distributed group values will be described with means, standard deviations and t-tests. Non normal distributed values as medians and IQR and Mann-Whitney to compare groups. Chi-square- or Fisherman's exact test (for small samples) will be used for cathegorical data. We assume a skewed distribution for all variables except age (and amplitude, areas and S2PD in uninjured hand). Pearson or Spearman correlation test for linear association, depending on whether data is parametric or non-parametric. Simple regression or multiple logistic regression for odds, both crude and adjusted. Odds will be presented with p-values (significance level $p< 0.05$) and CI. Correlation analysis with Receiving Operator's curves.

Sample size:
Power has been calculated in collaboration with a statistician.
There are no earlier studies on the subject and therefore it is impossible to calculate the exact number of patients needed for the study.
Power is set to 80% and significance level at a p-value <0.05. Significant differences in amplitude/area and standard deviations are hard to define since the method has not been used for these comparisons before. All possible differences between injured/uninjured fingers will therefore be analyzed.
In fingers without digital nerve injury, there are no major differences in S2PD. Significant difference in S2PD at clinical examination is set to 2mm in this project.
We have found that the adequate number of examinated patients to include in this study is 60.

Significance:
If this study can present a correlation between S2PD and area or amplitude we will be able to compare and evaluate sensory recovery after digital nerve injuries and interventions, in a more reproducible and objective way. We can be more certain of what we are testing and we can magnify the extent of the nerve injury. It will be helpful for the patients in their understanding and rehabilitation after a digital nerve injury that can cause lifelong impairment of hand function.

Ethics:
Ethical permit has been initiated.

Time plan:
Inclusion will start in 2024. End of study, 2025.

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