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Neurosensory findings among electricians with self-reported remaining symptoms after an electrical injury: A case series

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ABSTRACT

Purpose: Symptoms described in previous studies indicate that electrical injury can cause longstanding injuries to the neurosensory nerves. The aim of the present case series was to objectively assess the profile of neurosensory dysfunction in electricians in relation to high voltage or low voltage electrical injury and the "no-let-go phenomenon".
Methods: Twenty-three Swedish male electricians exposed to electrical injury were studied by using a battery of clinical instruments, including quantitative sensory testing (QST). The clinical test followed a predetermined order of assessments: thermal perceptions thresholds, vibration perception thresholds, tactile gnosis (the Shape and Texture Identification test), manual dexterity (Purdue Pegboard Test), and grip strength. In addition, pain was studied by means of a questionnaire, and a colour chart was used for estimation of white fingers.
Results: The main findings in the present case series were reduced thermal perceptions thresholds, where half of the group showed abnormal values for warm thermal perception and/or cold thermal perception. Also, the tactile gnosis and manual dexterity were reduced. High voltage injury was associated with more reduced sensibility compared to those with low voltage.
Conclusion: Neurosensory injury can be objectively assessed after an electrical injury by using QST with thermal perception thresholds. The findings are consistent with injuries to small nerve fibres. In the clinical setting thermal perception threshold is therefore recommended, in addition to tests of tactile gnosis and manual dexterity (Purdue Pegboard).

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1. Introduction

Electrical injury among adults are most commonly work related [1–3]. Previous studies have by convention categorized such injuries according to the electrical potential of the source into either low voltage (LV) (<1000 V) or high voltage (HV) (>1000 V) incidents [1,4,5].

Arnoldo et al. [1] showed in a registry study on 700 consecutive electrical burn admissions that acute complications and length of hospital stay were more severe among the HV-exposed subjects compared to the LV-exposed. This finding was supported by the results from a Swedish retrospective survey on 523 male electricians, where the frequency of reported symptoms remaining *more* than one week after the most severe self-rated electrical injury was higher among those electricians exposed to HV compared to LV injury [6].

Electrical injury may or may not be accompanied by a ''no-let-go'' phenomenon. The no-let go phenomenon refers to the sustained handgrip that follows from involuntary muscle contraction due to the electrical exposure and which thereby prolongs the contact time with the power supply [7]. The no-let-go phenomenon has been reported to occur in about one out of 10 incidents, according to the results of a survey conducted by the American Electricians' Union [8], while a prevalence as high as 26% was found in a Swedish retrospective survey on professional electricians [6]. Injury involving a no-let-go phenomenon were in the Swedish study followed by an increased frequency ($p \leq 0.05$) of sensory, muscular, and cognitive symptoms lasting more than one week compared to injuries without no-let go [6].

Hands or fingers account for the majority of the entry points and exit points [6,9], and most electrical injuries involve injury localized to the upper extremities, especially to the hands and fingers [3,9,10].

Among a sample of Swedish male electricians three percent reported remaining symptoms (range 1–45 years after the injury) [6]. The remaining symptoms were primarily pain, loss of sensation, and/or muscle weakness. Pain was also a prominent symptom when 18 men injured by an HV incident were evaluated (1–10 years after injury). A visual analogical pain scale score of more than five (range 0–10, where 0 equals no pain and 10 means the worst pain ever) was seen in 7 of the 18 patients [9]. Pain was also reported in a North American retrospective medical records study as the most common symptom, as almost all (93%) of the 55 patients reported pain, with hand being the most common location of pain (62%). There were no statistically significant differences in pain frequency between the HV and LV groups ($p = 0.24$) [11]. Neuropathic pain symptoms were reported by 40% (regardless of voltage group) approximately one year after the electrical injury in an American study covering 60 HV and 25 LV patients treated after electrical burns [4].

A few studies have discussed dysfunction of the sympathetic nervous system after an electrical injury [12,13]. In a single-case study where a patient had been exposed to HV, vascular symptoms (Raynaud's phenomenon, i.e. ''white finger'') became evident within one year after the incident [12]. Self-perceived dysfunction of the sympathetic nervous system including cold or warmth intolerance was found in nearly 60% of the 52 electrically burned patients [13].

The symptom narratives and descriptions from previous research [4,6,9,13] indicate a possible detrimental impact of electrical injury on motor-unit and neurosensory nerves. There are as yet no studies addressing the neurosensory function, specifically for the small-diameter fibres, with the diagnostic tools at hand – quantitative sensory testing – among subjects who have experienced an electrical injury.

The aim of the present study was to assess neurosensory injury in relation to a previously occurring electrical injury, to voltage power level, and to the possible effect modification of the no-let-go phenomenon.

2. Material and methods

2.1. *Study group*

The present study comprises a clinical descriptive case series of 23 Swedish male electricians exposed to electrical injury.

Fifty-eight authorized electricians who reported that they still had symptoms after an electrical injury were identified through a two-step questionnaire and were mailed a request for them to participate in clinical examinations. The two-step questionnaire was answered by 523 electricians who had sustained an electrical injury and were identified by the Swedish Electricians' Union (SEU) and the Swedish Work Environment Authority (SWEA). The study population and results of the questionnaires are reported elsewhere [6]. Electricians receptive to receiving more information were contacted by the researcher by phone, and 28 agreed to participate in the present study.

The inclusion criteria were males employed as electricians, with self-reported symptoms sustained after an electrical injury (regardless of time since incident). Exclusion criteria were presence of neurological or cardiovascular diseases or other severe conditions. Four of the electricians were excluded due to the exclusion criteria, and one did not attend the clinical examinations; thus, 23 participants formed the final study group.

2.2. *Procedure*

2.2.1. *Data collection and ethics*

Data were collected from August 2012 to November 2012 at the Occupational and Environmental Departments of five County councils (Gothenburg, Lund, Sundsvall, Umeå and Örebro). The study was approved by the Uppsala–Örebro Regional Ethics Committee (No. 2011/252) and was conducted in accordance with the 1964 Helsinki declaration. The participants gave their written consent before entering the study.

2.2.2. *Physical examination and medical history*

The clinical examinations took place at the respective participating Occupational and Environmental Departments and were performed by one examiner (LR), a registered physiotherapist. To refine the procedures and control for possible variability in methodology, complete assessments