BRIEF REPORT

Early signs of critical illness polyneuropathy in ICU patients with systemic inflammatory response syndrome or sepsis

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Abstract Objective: To evaluate with electromyography the incidence and the time of appearance of neuromuscular abnormality in patients with systemic inflammatory response syndrome (SIRS) and/or sepsis.

Design: Follow-up study.

Setting: Intensive care unit of Helsinki University Hospital, Finland.

Patients: Nine mechanically ventilated patients with SIRS and/or sepsis.

Interventions: Electromyography and conduction velocity measurements on the 2nd–5th day after admission to the intensive care unit.

Measurements and results: In all nine patients electromyography revealed signs of neuromuscular abnormality. The means of compound muscle action potential amplitudes of the median and ulnar nerves were decreased. Fibrillation was observed in four patients out of nine.

Conclusion: Because neuromuscular abnormalities seem to develop earlier than previously reported, electromyography should be used more frequently as a diagnostic test.

Key words Critical illness polyneuropathy · Systemic inflammatory response syndrome · Sepsis · Multiple organ dysfunction syndrome · Intensive care · Neuromuscular blocking agent · Electromyography

Introduction

Neuromuscular abnormality in intensive care unit (ICU) patients as a part of multiple organ dysfunction syndrome (MODS) is a common clinical problem (incidence 50–70%) [1]. Neuromuscular blocking agents (NMBA), corticosteroids, neurotoxic antibiotics, malnutrition, and immobilisation have been considered as the main etiological factors of critical illness polynuropathy (CIP) [1]. However, more recent studies offer evidence that systemic inflammatory response (SIRS) and sepsis may be causally related to axonal damage, much as is the case with other organ failures related to MODS [2, 3]. CIP is characterised by generalised primary axonal motor and/or sensory degeneration [3]. Other forms of critical illness neuromuscular abnormalities, e.g., type II fibre atrophy, motor axonopathy, and necrotising myopathy, can be differentiated from CIP by use
of electromyography (EMG) and conduction velocity (CV) studies and muscle biopsy [4, 5]. Clinically, CIP manifests with general weakness and sensory defects, and especially with weakness of the respiratory muscles leading to weaning problems from mechanical ventilation. At a later stage, difficulties in rehabilitation have been reported [6]. The most common symptoms, weaning difficulties and weakness, prolong patients’ ICU stay, and therefore CIP is usually suspected and recognised only in the late stage of the ICU period. Early diagnostic signs and risk factors are still mostly unknown. The importance of CIP as an independent prognostic factor is poorly understood, thus controlled studies are needed. Increased mortality has been reported among CIP patients, but this may be due to the severity of multiple organ failure [6].

We conducted a prospective follow-up study to evaluate the incidence and the time of appearance of CIP in ICU patients with EMG and CV studies.

### Materials and methods

#### Study design

The investigation was performed between September 1998 and April 1999 in the ICU of Helsinki University Hospital in Finland. The study protocol was approved by the ethics committee. Nine patients older than 18 years in need of mechanical ventilation on the day of admission to our ICU and with symptoms of SIRS or sepsis and developing MODS were included and informed consent was obtained. SIRS was diagnosed as two or more of the following conditions: (1) body temperature more than 38°C or less than 36°C; (2) heart rate more than 90 beats/min; (3) respiratory rate more than 20 breaths/min or PaCO2 less than 32 mmHg (before connection to ventilator); (4) white blood cell count more than 12000/mm³ or less than 4000/mm³; (5) more than 10% immature (band) forms [7].

Sepsis was defined as a positive blood culture. Developing multiple organ failure was defined as a multiple organ dysfunction score (MOD score) [8] of five or more on admission to the ICU. Exclusion criteria were pre-existing polyneuropathy or myopathy or any disease of the central nervous system (trauma, infections, tumours). Patients with other pre-existing diseases potentially damaging the nervous system (endocrinologic, hepatic, renal, rheumatologic) were excluded. Possible non-diagnosed neurological damage was estimated from previous medical records (working capacity, disabilities).

All patients were investigated electrophysiologically 2–5 days and 14 days after admission to the ICU. Investigation in the ICU included needle electromyography with transportable EMG equipment (Medelec Saphire, UK).

Motor conduction velocity of the median and ulnar nerves were measured with surface electrodes. A short repetitive stimulation of 2 Hz was applied to rule out drug effect on neuromuscular junction. Muscle action potential was plotted and the negative peak amplitude measured. Sensory potential and CV were measured on the radial and sural nerves. Skin temperature was above 31°C in all recordings.

Needle EMG, using concentric needle electrodes, was recorded on the anterior tibial, vast lateral and first dorsal interosseal muscles of the hand. The presence of fibrillations was graded from 0 (= no fibrillation) to 3 (= maximal fibrillation). No voluntary activity could be recorded because the patients were unconscious.

The results were compared to the normal values in the literature [9]. The normal lower limit for median nerve motor CV was 50 m/s, for the ulnar nerve motor CV, 48 m/s. The lower limit of normal value for the amplitude of the median motor response was 5 mV and ulnar motor response, 3 mV.

All patients were ventilated with Servo 300-ventilator (Siemens, Stockholm, Sweden) on pressure-control mode or biphasic positive airway-pressure mode. Non-depolarising NMBA cisatracurium (Nimbex, Glaxo Wellcome, UK) was administered only on an intermittent basis during therapeutic procedures, if needed. Corticosteroid treatment was used only on the recommendation of a consultant of infectious diseases. All patients were sedated with propofol and fentanyl infusions at clinically estimated doses.

### Results

All nine patients developed signs of CIP on the 2nd–5th day after admission to the ICU (see Table 1). Mean MOD score on admission was 7.7 (5–13). Compound muscle action potential (CMAP) amplitudes of the median and ulnar nerves were reduced: mean 2.5 mV (1.0–4.7) and 2.8 mV (1.0–5.4), respectively. In four out of nine (45%) patients, some fibrillation potentials were present in the anterior tibial and vast lateral muscle. Motor (median and ulnar) and sensor (radial and/or sural) conduction velocity studies were mainly normal.

On the 14th day after admission to ICU, four out of five patients had decreased CMAP amplitudes in EMG. One patient had increased CMAP amplitudes compared to baseline EMG. This patient (no. 8) had fibrillations as a diagnostic sign of polyneuropathy in the repeated EMG. Four patients were not studied, because patients 2, 4, and 6 died, and patient 9 was discharged.

Of the nine patients, three had moderate tissue oedema in the inferior extremities and four had only mild oedema. Three patients had no oedema. Tendon reflexes were normal on admission.

### Discussion

The main finding in our study is the early development of neuromuscular dysfunction in patients with SIRS/sepsis diagnosed by EMG and CV studies. In our protocol, the baseline examination was done for all patients in the early stage of the inflammatory response 2–5 days after admission to ICU with no clinical evidence present of developing neuromuscular damage.

The aim of the early EMG study was to record baseline status before the development of CIP. Unexpectedly, as early as 2–5 days after admission to the ICU (on the 2nd–7th day of illness) the EMG was clearly abnormal.