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Autonomic dysfunction and osteoporosis after electrical burn

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ABSTRACT

Introduction: Several studies have shown the importance of the sympathetic nervous system in bone metabolism. There is an evidence of sympathetic skin response (SSR) impairment in electrical burn patients up to 2 years after their injuries. The acute phase of burn is accompanied by increased bone resorption. Whether the prolonged dysfunction of sympathetic nervous system may result in bone metabolism derangement even after the acute phase of electrical burn is the inspiring question for this study. And we tried to find correlation between SSR abnormality and areal bone mineral density (BMD) in electrical burn patients 6 months or more after the incidents.

Methods and materials: 42 electrical burn patients (≥6 months prior to study) who did not have a known joint or bone disease, history of neuropathy (central or peripheral), diabetes mellitus or consumption of any drug affecting the autonomic nervous system or evidence of neuropathy in nerve conduction study were recruited. We also gathered a control group of 50 healthy subjects (without electrical burn or the exclusion criteria). They went under dual energy X-ray absorptiometry and SSR study. Data were analyzed statistically with SPSS 16.0 making use of independent *t*-test and Pearson correlation coefficient. $P < 0.05$ was considered significant statistically.

Results: Areal BMD was significantly lower in electrical burn patients than control group ($P < 0.001$). SSR latency was significantly prolonged and its amplitude was significantly reduced in burn patients compared to control group ($P < 0.001$). In burn patients there was an inverse correlation of areal BMD of lumbar vertebrae, left femur neck and total femur with SSR latency and a direct correlation of areal BMD with SSR amplitude. In control group there was just direct correlation of areal BMD of lumbar vertebrae and left femur neck with SSR amplitude.

Conclusion: Electrical burn patients are at risk of reduced areal BMD long after their injuries. Sympathetic derangement and impaired SSR are correlated with reduction in areal BMD in these patients.

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1. Introduction

Osteoporosis (OP) is a major health problem because of morbidity and mortality rate of the osteoporotic fractures. On-time diagnosis and treatment of this pathology might help to prevent fractures and reduce the morbidity and mortality of victims. Precise mechanisms of bone homeostasis are not known yet. However, there is an increasing body of evidence pointing to the role of nervous system in skeletal growth and bone turnover. Several studies have shown the importance of sympathetic nervous system in bone metabolism [1–6].

Histological studies have shown that bone and periosteum receive a rich supply of sensory and sympathetic nerve fibers. It has been revealed that beta-adrenergic blocking agents increase bone mineral density and decrease fracture risk in adult population and it is suggested that this drug may establish a new therapeutic approach in the treatment of OP [3,7–11]. There is also some evidence of a direct correlation between impaired sympathetic skin response (SSR), an indicator of sympathetic nervous system dysfunction, and postmenopausal osteoporosis [11].

Impairment of SSR in electrical burn patients was shown by Ashraf et al. [12]. This impairment can last as long as 2 years after electrical burn [13]. In these two studies SSR changes in electrical burn patients were shown in all 4 limbs irrespective of the electrical current entry or exit sites, showing that these changes are the result of a systemic process rather than the local effects of burn. The authors also excluded any patient with severe skin scarring that would technically interfere with SSR results. Although non-obvious changes in the sweat glands of the skin directly affected by electricity would confound the results, this fact that SSR changes found even in the limbs not directly affected by electricity and had apparently normal skin makes this confounder of little importance [12,13].

Acute phase of burn is accompanied by hyper-metabolic state. Increased bone resorption in this phase has been shown by previous studies [14]. The role of sympathetic nervous system derangement in bone resorption in the acute phase of burn is puzzling. And whether prolonged dysfunction of sympathetic nervous system may result in bone metabolism derangement even after the acute phase of electrical burn or not is up for debate. So, the present study was designed to find correlation between SSR abnormality and areal bone mineral density in electrical burn patients 6 months or more after their injuries.

2. Methods and materials

We got the approval of Shiraz University of Medical Sciences for this study and the procedures used. The old charts of 63 registered patients with electrical burns in Shiraz burn center (Ghotbedin hospital) were reviewed. Those patients who had experienced electrical burn 6 months or more prior to the study were invited to participate in our study. We excluded any patient who was admitted in ICU for more than 1 week. By excluding these patients we tried to minimize the potential effect of bed rest and other critical illnesses on the SSR and BMD. We also excluded any patient with a known joint or bone disease, positive history of neuropathy (central or peripheral), Diabetes mellitus or consumption of any drug affecting the autonomic nervous system. Any patient with cast, skin lesion, skin graft, or scar at the sites of SSR recording or stimulus (palms, soles, wrists, or ankles) that made technical problems for SSR recording was also excluded.

None of our study group had positive history or any sign of end organ failure. Regarding the exclusion criteria, those patients injured by high voltage electricity were excluded from the study since they had either long ICU admission, skin grafts, severe scarring or even amputation of one or more limbs. And all the patients included were injured by low voltage electrical current.

After filling in the written informed consent the patients went under 4 limb nerve conduction study and electromyography. Any patient with evidence of peripheral neuropathy was excluded.

The study was conducted with 42 patients who agreed to participate in the study and had none of the exclusion criteria. All the patients were male, with mean age of 32.1 ± 6.9 years. The mean time from the injury was 16.2 months. We also gathered a control group of 50 healthy male (without electrical burn and without having any exclusion criteria). The mean age of this group was 29.9 ± 3.8 years. We gathered the control group from the patients' families (brother, cousin, uncle) so that the control group is matched with the patients in terms of genetic, socioeconomic class and nutrition as much as possible.

All the participants underwent dual energy X-ray absorptiometry (using LUNAR DFX IQ #5564) to determine the bone mineral density and *T* and *Z* scores at lumbar vertebrae (L2-L4) and left femur (Neck, WARDS, Troch and shaft areas). They also went under SSR study.

Using a Synergy multilinker EMG machine, SSR was performed in a quiet room, with patients in supine position keeping them alert and awake.

They were asked not to laugh, sigh, cough, or breathe deeply during the study. The room and skin temperatures were kept at 24 °C and 32 °C, respectively. The active and reference electrodes were put on the palm and dorsum of each hand respectively to record the SSR to median nerve stimulation at the wrist ipsilateral to the recording side. We also put the active and reference electrodes on the sole and dorsum of each foot respectively in order to record the response to tibial nerve stimulation at the ankle ipsilateral to the recording side.

We used a band pass of 0.5–2000 Hz, amplification of 100–200 μV/div and a base time of 500 ms/div. Ten stimuli of 20–45 mA intensity and 0.2 ms duration were used at random intervals of more than 30 s (in order to avoid habituation). Peak to peak amplitude and onset latency of the SSR were recorded.

The gathered data were analyzed statistically using SPSS 16.0. Then the results were expressed as mean value and standard deviation (SD). Independent sample *t*-test was also used for comparing means between the two groups. And the correlation between quantitative variables was tested with Pearson correlation coefficient. $P < 0.05$ was considered statistically significant.

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