Electromyographic changes in thyrotoxicosis

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ABSTRACT

Objectives: To document electromyographic (EMG) changes in thyrotoxic patients, and to categorize the type of myopathic process in thyrotoxicosis.

Methods: This case control study was designed to show the EMG changes in thyrotoxic patients and to compare these findings with that of normal aged matched controls to show the significance of these changes in thyrotoxic patients. Student's test was applied on the results and P value was extracted. Subjects in this study were chosen according to certain criteria depending mainly on their blood level of thyroid hormone (triiodothyronine and thyroxine) and thyrotropin. All of them are thyrotoxic patients, with age range between 15-45 years. There were 25 patients, 15 female and 10 male. Another 25 subjects of the same age and sex were chosen as normal controls. Patients with features of myopathy or neuropathy from diseases other than thyrotoxicosis were excluded carefully from studied patients and the normal controls.

Results: The EMG findings in thyrotoxic patients were as follows: No spontaneous activities in the proximal muscles (deltoid and in rectus femoris muscles). The amplitude of the motor unit action potentials ranged between 200-800 microv with a mean of 488.8±159.3 microv in the deltoid muscle, while the amplitude of the action potential in rectus femoris muscle in thyrotoxic patients ranged between 350-900 microv. In abductor pollicis brevis muscle the action potential amplitude in thyrotoxic patients ranged between 500-2150 microv, there was significant difference between thyrotoxic patients and normal controls. The duration of the motor unit potential in thyrotoxic patients ranged between 7-11.5 msec with a mean of 8.51±1.24 msec in the deltoid muscle, slightly higher figures in rectus femoris muscle, indicating significant difference in the duration of action potential between patients and normal controls. The other parameters of the EMG study indicate a myopathic process involving proximal muscles in 76% of thyrotoxic patients and a neuropathic process involving distal muscles in 28% of thyrotoxic patients.

Conclusions: Thyrotoxicosis involves proximal muscles more than distal muscles. The myopathic process in thyrotoxicosis can be observed clearly in the EMG study of the proximal muscles. The EMG findings in thyrotoxic myopathy includes short duration polyphasic potentials with early recruitment full interference pattern. The distal muscles in thyrotoxic patients may show EMG findings of a rather neuropathic process.

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Thyrotoxicosis is a common clinical syndrome consequent to excess circulating thyroid hormone that can be caused by a number of different disorders such as Grave's disease, toxic multinodular goiter or toxic thyroid adenoma, thyroiditis, iodide-induced hyperthyroidism, factitious thyroiditis and thyrotoxicosis due to excess thyrotropin (TSH).[1] The complaint of weakness is common in thyrotoxicosis and it represents the presenting symptom in 5% of patients,[2] physical examination may reveal weakness or wasting in 60-80% of thyrotoxic patients.[3] Muscle disorders observed in thyrotoxic patients are chronic thyrotoxic myopathy,

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exophthalmic ophthalmoplegia, myasthenia gravis with toxic goiter and periodic paralysis with thyrotoxicosis. Thyrotoxic myopathy is characterized by progressive weakness and wasting of skeletal muscles, occurring in conjunction with overt or covert thyrotoxicosis. The myopathic process more commonly involves muscles of the pelvic girdle and thighs. The shoulder and hand muscles show the most conspicuous atrophy. Adequate treatment of thyrotoxicosis usually results in full recovery of the bulk and power of the skeletal muscles involved in a matter of 2-3 months.[4-6] The frequency of myasthenia gravis in thyrotoxic patients is 20-30 times that of the general population.[5] Electromyographic (EMG) changes in thyrotoxicosis appear predominantly in the proximal muscles, even if no muscle weakness is demonstrated clinically. These abnormalities may be observed in 60-100% of patients.[7] The most frequent changes are shortened mean potential duration and increased polyphasia. Even at reduced strength of contraction there is a full interference pattern.[4,7]

Methods. In this study 25 Iraqi thyrotoxic patients and another 25 age matched normal controls were chosen in order to study EMG changes in thyrotoxicosis and to compare the results to that of normal controls. Thyrotoxic patients were included in this study according to their blood level of thyroid and TSH hormones: Thyroxine (T4) range was 18.5-32 mg/dl (mean 23.8±5.4, normal value 4.5-12.5 mg). Triiodothyronine (T3) range was 2.5-4.2 nmol/L (mean 3.2±0.7, normal value 0.8-1.8 nmol/L). Thyrotropin range was 0.08-0.3 mu/ml (mean 0.23±0.1, normal value 0.3-4.5 mu/ml). All patients and controls were fully examined neurologically for features of muscular weakness. Laboratory investigations including creatinine phosphokinase (CPK), serum potassium, electroencephalographic (EEG) and prostigmine tests were carried out as needed. The patients were screened for other medical disorders or family history that is related to the production of different muscular diseases. Electromyography was carried out in the morning and at room temperature 25-27°C. Neuromatic 2000 M equipment was used in this study with concentric needle electrodes. The muscles used for EMG sampling in most patients and control are the right abductor pollicis brevis, right deltoid and right quadriceps femoris. After disinfecting the skin overlying the muscle to be examined the needle electrode was inserted. The following parameters were significantly looked for during EMG examination of these muscles: 1. Spontaneous activity or insertional activity when the muscles are relaxed. 2. Motor unit amplitude, duration, shape, and percentage of polyphasia, were recorded and studied while the patient performed weak contraction of the muscles under examination. 3. Polyphasia of more than 12% was considered abnormal (20 different motor unit potentials of each muscle were recorded). 4. The pattern of electrical activity during maximum contraction was studied (interference pattern). Statistical analysis was applied on the results using Student's t-test, a p-value <0.05 was considered to be significant.

Results. ***Spontaneous activity in relaxed muscles.*** In thyrotoxic patients there were no spontaneous activities in the deltoid and in the rectus femoris muscle, only 3 out of 25 patients showed spontaneous activities in their relaxed abductor pollicis brevis muscle. No significant spontaneous activity was detected in the control group.

Motor unit potentials at weak voluntary contraction.

1. The amplitude of motor unit potentials. In thyrotoxic patients the amplitude of the motor unit action potentials ranged between 200-800 microv with a mean of 488.8±159.3 microv in the deltoid muscle in comparison to the normal controls in which it ranged between 400-1300 microv with a mean of 658±182.9 microv. There was significance difference between the patients and the normal controls ($p<0.002$). Electromyographic examination of rectus femoris muscle showed that amplitude of the action potential in thyrotoxic patients ranged between 350-900 microv with a mean of 578±158 micro, while in the normal controls the amplitude ranged from 500-1500 microv with a mean of 578±205.99 microv. The p-value ($p<0.005$) showed significant difference between the patients and the normal controls. Examination of the abductor pollicis brevis muscle revealed that the action potential amplitude in thyrotoxic patients ranged between 500-2150 microv with a mean of 820±410 microv, while in the normal controls the amplitude ranged between 320-1200 micro with a mean of 610.8±223.8microv. There was significant difference between the patients and the normal controls ($p<0.05$).

2. The duration of the motor unit potential. The duration of the motor unit potential in thyrotoxic patients ranged between 7-11.5 msec with a mean of 8.51±1.24 msec in the deltoid muscle. In the normal controls, the duration was 9-11.3 msec with a mean of 10.22±0.65 msec, the difference was significant ($p<0.001$). The duration of the motor unit potential in the rectus femoris muscle ranged between 7-14.5 msec with a mean of 9.96±2.03 msec in thyrotoxic patients. In the normal controls the duration ranged between 10-14.1 msec with a mean duration of 12.36±1.137 msec. There was significant difference between the patients and the normal controls ($p<0.001$). The duration of the muscle action potential in the abductor pollicis brevis muscle ranged between 8-12.8 msec with a mean of 9.86±1.11 msec in thyrotoxic patients. In the normal controls, the range was between 8-10 msec with a mean of 8.78±0.56 msec. There was significant difference between the patients and the normal controls ($p<0.002$).

3. The shape of motor unit potential. In normal subjects the shape of motor unit potential was mainly diphasic or triphasic, polyphasic potentials were very few, their percentage below 12% and the duration

mostly within the normal range. In thyrotoxic patients the shape of motor unit potentials was diphasic or triphasic, but the percentage of polyphasic potentials of short duration in proximal muscles was high. In the deltoid muscle 72% of thyrotoxic patients showed polyphasic potentials of short duration (more than 12%) and ranging between 20-40%. In the rectus femoris muscle, 60% of thyrotoxic patients showed polyphasic potentials of short duration ranging between 20-50%. In the abductor pollicis brevis, muscle of thyrotoxic patients the shape of the motor unit potentials was mainly diphasic or triphasic, but only 3 patients showed polyphasic potentials more than 12% of long duration action potentials.

4. The interference pattern. Thyrotoxic patients showed early full interference pattern in deltoid and rectus femoris muscles, while in abductor pollicis brevis muscle all patients showed normal interference pattern except 2 patients in whom decreased interference pattern in maximum voluntary contraction was observed. In normal subjects, normal interference pattern was observed.

5. Mean potential duration evaluation. In order to evaluate the mean potentials duration which is affected by patients age, thyrotoxic patient were divided into 3 groups, first group their ages ranged between 15 to 25 years and comprised of 10 patients, the second group between 25 to 35 years and comprised of 9 patients and the third group between 35 to 45 years and comprised of 6 patients. In the deltoid muscle, there was no abnormal potential duration in the control group. In thyrotoxic patients, 7 (70%) patients from the first group, 7 (77.7%) patients from the second group, and 5 (83%) patients from the third group showed abnormal short potential duration compatible with diagnosis of myopathy, representing 76% of the patients. In rectus femoris muscle, 8 (80%) patients from the first group, 2 (22.2%) patients from the second group, and 4 (66.6%) patients from the third group showed abnormal short potential duration, representing 56% of the patients. The control group did not show any abnormal potential duration.

In distal muscle sampling (the abductor pollicis brevis) there was no abnormal potential duration in the control group. While in thyrotoxic patients there was no abnormal potential duration in the first group, only 2 patients in the second group, and 5 patients in the third group showed abnormal long potential duration resembling that of neuropathic pattern. These finding were present in 28% of the patients.

Discussion

Previous electrophysiological studies of the muscles in thyrotoxic patients had proved myopathic changes in the proximal muscles ranging between 60-100%. This study confirms such findings in thyrotoxic Iraqi patients. In normal subjects, all muscles sampled were silent during relaxation. In thyrotoxic patients spontaneous activity in the proximal muscles was also absent, but distal muscles (abductor pollicis brevis muscle) showed fibrillation potentials, positive sharp waves, or both, in 3 out of the 25 patients, possibly due to peripheral nerve damage. McComma[9] had reported such changes also in thyrotoxic patients, and other studies also proved such findings.[10-12]

In this study the mean amplitude of the motor unit potential of the proximal muscle (deltoid and rectus femoris) in thyrotoxic patients was significantly lower than that of the control group. Similar findings were reported by others[2] and this indicates loss of muscle fibers and reduced fiber density, these changes are in favor of myopathic disorder.[7] The mean duration of motor unit potential in the proximal muscles in thyrotoxic patient was significantly shorter as compared to the control group, in agreement with other findings.[3,6,13] This finding also suggests loss of muscle fibers and reduced fiber density as a result of a myopathic process.[8] The evaluation of mean potential duration in thyrotoxic patients showed abnormal potential duration in the proximal muscles in up to 76% of the patients. Similar findings were also reported by others.[7] Abnormal long potential duration in distal muscles was present in up to 28% of the patients indicating a rather neuropathic process, again such findings were also reported by others.[14]

Polyphasic potentials were significantly reported in thyrotoxic patients (polyphasia more than 12%). However, polyphasia in thyrotoxic patients is usually accompanied by short duration potential not like that found in neuropathic disorders where polyphasia is usually accompanied by long duration potentials indicating axonal or anterior horn cells degeneration. The same findings were reported by others.[3] These finding also suggest loss of muscle fibers in the motor unit, which is in favor of myopathic process.

In normal subjects all muscles examined showed good interference pattern indicating normal strength of muscle contraction,[7] while in thyrotoxic patients the proximal muscles showed early recruitment full interference pattern, similar findings were reported by other studies.[2] Distal muscles in thyrotoxic patients showed normal interference pattern except in 2 cases were interference pattern was abnormally reduced most likely due to a neuropathic process, such findings were also reported by McComma et al.[9]

In conclusion, thyrotoxicosis affects proximal muscles more than distal muscles. The myopathic process in thyrotoxicosis can be observed clearly in EMG study of the proximal muscles. The EMG findings in thyrotoxic myopathy includes, short duration polyphasic potentials, with early recruitment full interference pattern. Distal muscles in thyrotoxic patients may show EMG findings of a rather neuropathic process.

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