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Lipid Peroxidation and Superoxide Dismutase Activity in Muscle and Erythrocytes in Adult Muscular Dystrophies and Neurogenic Atrophies

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Summary. Lipid peroxidation (LP) and superoxide dismutase (SOD) activity were determined in erythrocytes and skeletal muscle obtained from patients with limb-girdle and facioscapulohumeral muscular dystrophies, neurogenic atrophies and from age-matched control subjects. Neither lipid peroxidation nor SOD activity in erythrocytes of patients differed from control values. SOD activity and LP in muscle specimens were also normal in types of neurogenic atrophy. Lipid peroxidation in the muscle from patients with adult types of muscular dystrophy had a tendency to be increased. The values were widely scattered, the highest being obtained in the older patients with long duration of disease.

Key words: Erythrocytes – Muscle – Lipid peroxidation – Neuromuscular diseases

Introduction

Lipid peroxidation and other free radical reactions are generally believed to have a role in damaging biological structures – especially membranes – and cellular functions (Del Maestro 1980; Kar and Pearson 1979). The damaging effect of oxygen toxicity has been suggested in muscular dystrophies by Kar and Pearson (1979) and by Mechler et al. (1984), although controversial data have also been reported (Burri et al. 1980; Hunter et al. 1981; Matkovics et al. 1982). In the present paper, lipid peroxidation (LP) and superoxide dismutase (SOD) activity were studied in erythrocytes and muscle obtained from patients with limb-girdle (LG) and facioscapulohumeral (FSH) forms of muscular dystrophy, neurogenic atrophies and from age-matched control subjects to determine whether the increased muscle lipid peroxidation is specific to Duchenne muscular dystrophy (DMD).

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Material and Methods

Six patients with LG and four with FSH dystrophy (mean age: 31 and 28 years, respectively), ten patients with motor neurone disease (mean age: 45 years) and age-matched control subjects were investigated. In the group of patients suffering from motor neurone disease, six had amyotrophic lateral sclerosis (ALS), two spinal muscular atrophy (SMA) of type III and two peroneal muscular atrophy (PMA).

Blood samples were collected in heparin tubes in the morning by routine venepuncture. Muscle specimens were obtained by taking biopsy specimens of quadriceps femoris muscle (vastus lateralis). Control biopsies were obtained from the same muscle during orthopedic surgical intervention in individuals not suffering from neuromuscular diseases.

The SOD activity in erythrocytes was measured by the method of Concetti et al. (1976) and was related to the hemoglobin content. The LP in erythrocytes was determined by the method of Mengel and Kann (1966). The malondialdehyde (MDA) content was measured and related to hemoglobin. LP and SOD activity in muscle was determined according to the method described by Kar and Pearson (1979) and related to the non-collagen protein content.

The details of the methods were described in a previous paper (1984). The data were statistically analyzed by Student's *t*-test.

Results

Neither in erythrocytes nor in muscle obtained from the patients were the mean values of SOD activity different from the controls (Figs. 1, 2).

The LP activity in both erythrocytes and muscle was similar in patients with neurogenic atrophy and their controls (Fig. 3). No significant difference was found in LP activity in erythrocytes between the patients with muscular dystrophies and age-matched controls (Fig. 4). However, the individual values of LP in muscles from muscular dystrophies were highly scattered, and the high values were found in the older patients with a longer duration of disease (Fig. 4). A significantly positive correlation was observed be-

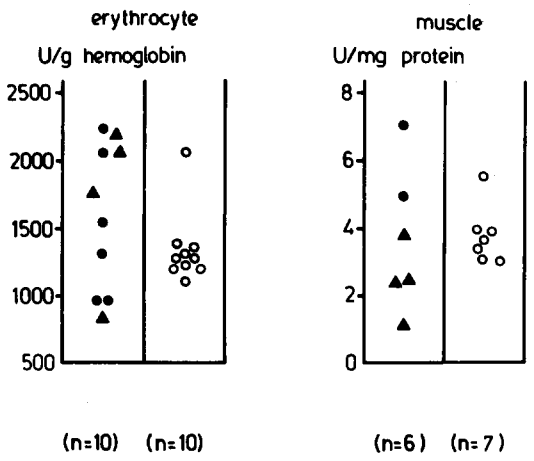

Fig. 1. Superoxide dismutase activity in erythrocyte and muscle in patients with limb-girdle (*LG* ●) and facioscapulohumeral (*FSH* ▲) muscular dystrophies and age-matched controls (○)

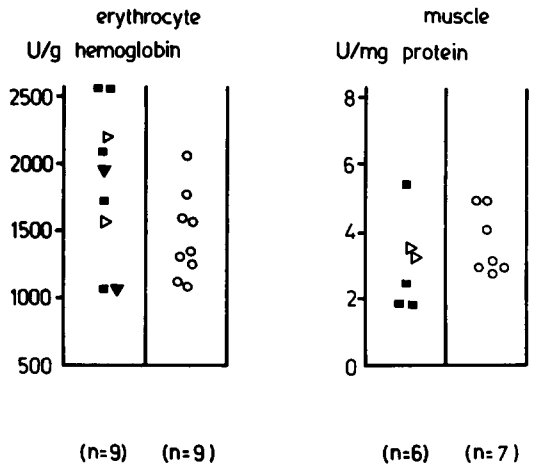

Fig. 2. Superoxide dismutase activity in erythrocyte and muscle in patients with neurogenic atrophies (*ALS*, amyotrophic lateral sclerosis ■; *SMA*, spinal muscular atrophy ▲, *PMA*, peroneal muscular atrophy △) and age-matched controls (○)

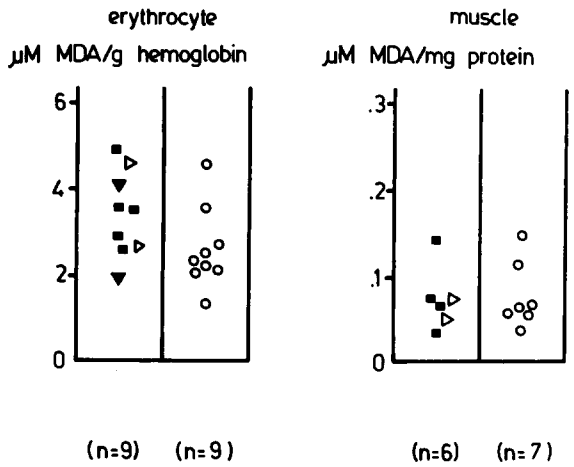

Fig. 3. Lipid peroxidation in erythrocyte and muscle in patients with neurogenic atrophies and controls. *MDA*, Malondialdehyde; other symbols as in Fig. 2

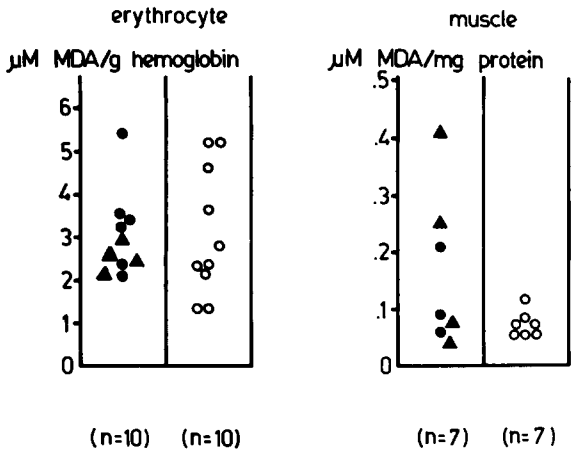

Fig. 4. Lipid peroxidation in muscle and erythrocyte in patients with limb-girdle (*LG* ●) and facioscapulohumeral (*FSH* ▲) muscular dystrophies and in controls (○). *MDA*, Malondialhehyde

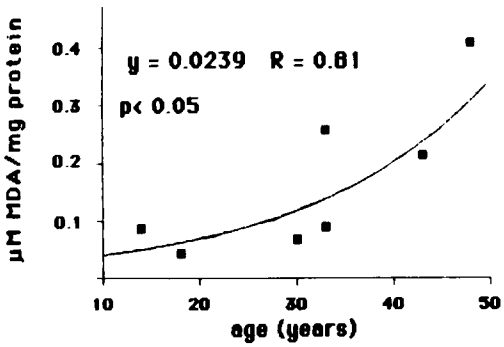

Fig. 5. The connection between lipid peroxidation in muscle and age of patients with muscular dystrophies

Table 1. Clinical data of patients with types of muscular dystrophy

Patients and diagnoses	Age (years)	Severity of disease	LP values in muscle[a]	CK activity in serum[b]
1. LG	43	+++	0.213	467
2. LG	33	+++	0.091	521
3. LG	30	++	0.069	163
4. LG	48	+++	0.411	103
5. FSH	33	++	0.258	154
6. FSH	14	+	0.087	283
7. FSH	18	++	0.043	180

[a] μM MDA/mg protein; [b] U/l; LP = Lipid peroxidation
LG, Limb-girdle dystrophy; FSH, facioscapulohumeral dystrophy
+ Mild; ++ moderate; +++ severe

tween muscle LP values and the age of the patients with muscular dystrophies (Fig. 5). There was no relation between muscle LP and serum CK activity. The CK values did not correlated with age or with the severity and duration of diseases (Table 1).

In contrast to the muscular dystrophies, no correlation was found between the LP or SOD activities and either age or the duration of symptoms in the neurogenic atrophies. No correlation was observed between LP or SOD activities and age in controls.

Discussion

Oxygen toxicity has been suggested as playing a special role in the manifestation of muscle damage in dystrophic animals (Omaye and Tappel 1974) and in neuromuscular diseases (Burri et al. 1980; Kar and Pearson 1979; Matkovics et al. 1982; Mechler et al. 1984). The individual values of LP in muscle were found to be widely scattered in LG and FSH types of muscular dystrophy. In three relatively older patients with longer duration of disease, the LP was essentially higher than the mean control value, while it was within the control limits in young patients. The significantly positive correlation between muscle LP and age of patients with adult types of muscular dystrophies reflects the connection between LP and the duration of disease (the onset of symptoms started in the second decade in all of our patients). There seems to be a similar tendency in muscle LP changes in adult types of muscular dystrophy, as was previously observed in Duchenne muscular dystrophy. However, the increase of muscle LP in LG and FSH was far from the high elevation found in DMD (Mechler et al. 1984). The difference might be because the rate of progression is much faster; the wasting of muscle and the membrane destruction are more severe in DMD than in adult types of muscular dystrophy. The normal LP both in muscle and erythrocytes of patients with neurogenic muscular atrophies suggests that free radical reactions have no role in the muscle damage of neurogenic atrophies.

The findings presented here do not indicate an altered antioxidative capacity of SOD in muscular dystrophies and neurogenic atrophies. This is consistent with our previous results in DMD (Mechler et al. 1984) and the observations of Myllylä et al. (1986) in neuromuscular diseases.

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