Chronic trapezius myalgia

Morphology and blood flow studied in 17 patients

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Bilateral open biopsies from the painful upper part of the trapezius muscle were studied in 17 patients with localized chronic myalgia related to static load during repetitive assembly work. Isolated pathologic ragged red fibers were related to the presence of myalgia. The phenomenon indicating disturbed mitochondrial function was confined to the Type 1 fibers. Using a laser-Doppler flowmeter, the muscle blood flow was recorded in the exposed muscle before a biopsy was taken. Pain was assessed and graded as the difference between the two sides, as was the presence of ragged red fibers. The myalgia correlated with reduced local blood flow: the greater the pain difference, the greater the reduction in blood flow. There was a correlation between the presence of mitochondrial changes and reduced muscle blood flow.

Industrial employees are often exposed to static load in the shoulder-stabilizing muscles over excessively long periods of time. Complaints from the neck and shoulder muscles are common causes of long-term sick leave, and may show a poor prognosis (Kvarnström 1985). In a previous investigation (Larsson et al. 1988) of patients with localized chronic myalgia related to a static load during repetitive assembly work, we reported morphologic changes indicating mitochondrial pathology in muscle biopsies from the descending portion of the trapezius muscle. The phenomenon was confined to Type 1 fibers, which also showed increased frequency. Biochemical examinations showed reduced levels of adenosine triphosphate and adenosine diphosphate, whereas lactate, pyruvate, and glycogen levels were normal, as well as phosphoryl creatine and total creatine.

We now report examinations in a larger number of patients to check whether mitochondrial changes in chronic trapezius myalgia could be related to disturbed local blood flow. Patients with persistent myalgia despite long-term absence from work were studied.

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Patients and methods

Seventeen patients with work-related chronic myalgia of the trapezius muscle(s) were studied. They were all females with a mean age of 39 (19–58) years and with symptoms of 5 (1–13) years duration. They had been doing highly repetitive assembly work for 15 (2–28) years with high demands of frequent precision movements in a sitting posture.

As in our previous study (Larsson et al. 1988), comprehensive clinical and laboratory investigations were performed in order to exclude other rheumatologic or neuromuscular disorders. All the patients had major complaints of pain and tenderness distinctly localized to the descending part of the trapezius muscle, and especially on the side that had been most exposed to static load. None had complaints from the cervical spine and the shoulder joints, and the physical examination was normal in these respects. There was no evidence of generalized muscle pain or stiffness, nor inflammatory joint disease. All the patients were examined by two of us (SEL and LB). The general physical examination and laboratory tests were normal. Blood samples had been analyzed for erythrocyte sedimentation rate, hematology count, electrolytes, creatinine, liver enzymes, creatine kinase, thyroid function (thyroxin), trijodothyronine, T-tri uptake test, thyroid-stimulating hormone, rheumatoid factor (latex fixation test and the Waaler-Rose test), and finally, antinuclear antibodies.

Open muscle biopsies measuring approx. 2 × 3 mm were taken bilaterally from sites corresponding to the tender part of the upper portion of the trapezius muscle. The biopsy included areas where blood flow recording had been made prior to the removal of the specimen. With the subject in the prone position, the skin and the most superficial subcutaneous fat were infiltrated with a local anesthetic; care was taken to avoid the muscle. No sedatives were given before the biopsy.

Blood flow recordings were made of the subcutaneous fat tissue, the exposed muscle fascia with the underlying muscle, and, finally, the exposed muscle fibers in habitual rest, at voluntary isometric contraction done in the prone position and during the following rest. A laser-Doppler flowmeter (Periflux® Pfld Perimed, Stockholm, Sweden) was used. This instrument has been described by Nilsson et al. (1980a, b). The recorded flow value is linearly related to the flux of red cells (the number of cells × their velocity), and is virtually independent of flow direction. Thus, the method has high precision. All the blood flow values were expressed in volts and recorded on an analog tape, as well as on a pen recorder, for later evaluation on a computer (Hewlett Packard Fourier Analyzer 5451C). The measuring volume constituted approximately a hemisphere with a radius of about 1 mm (Nilsson et al. 1980b).

The readings were made once for a period of 1 minute. The computed mean value expressed the microvascular flow during this period. The results were given as the obtained difference between comparable recordings of the right and the left muscle. Calibration for the examined tissue volume can be made only in exceptional circumstances. Consequently, normal values for laser flowmetry of skeletal muscle are not known.

Muscle biopsies were removed as atraumatically as possible and subjected to routine histopathologic and histochemical examinations. Serial sections of the formalin-fixed material were made at different levels of the biopsy. Formalin-fixed and paraffin-embedded specimens were stained with hematoxylin-eosin, Weigert's hematoxylin, Van Gieson's and Ladewig's stains. Specimens frozen in liquid nitrogen were stained for ATPase, NADH-tetrazolium reductase, phosphorylase, and acid phosphatase. For fiber typing, staining for myofibrillar adenosine phosphate (ATPase) preincubation at pH 9.4 and pH 4.6 was used. Type 1 and type 2 fibers were identified by respectively light and dark staining for ATPase at pH 9.4. A modified Gomori's trichrome-hematoxylin-eosin and Van Gieson's stains were also used on the frozen material. Periodic acid Schiff (PAS) was used for staining glycogen and Oil red-O for lipids.

A "ragged red fiber" was defined by the existence of subsarcolemmal zones of bright red or reddish-blue material when staining with Gomori-trichrome and an accumulation of formazan particles in the same area when staining for NADH-tetrazolium reductase (Bengtsson et al. 1986). These fibers also had a "ragged" appearance.

The degree of pain was assessed in four classes according to the degree of pain difference between the right and left trapezius muscles: 0 = equal pain; 1 = slightly more pain on one side; 2 = definitely more pain on one side; and 3 = pronounced pain on

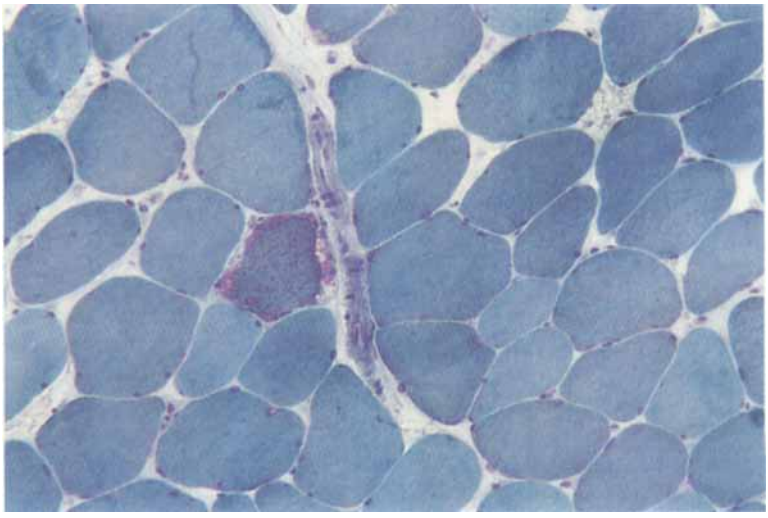

Figure 1. Biopsy showing ragged red fiber in the trapezius muscle. Gomori's trichome staining.

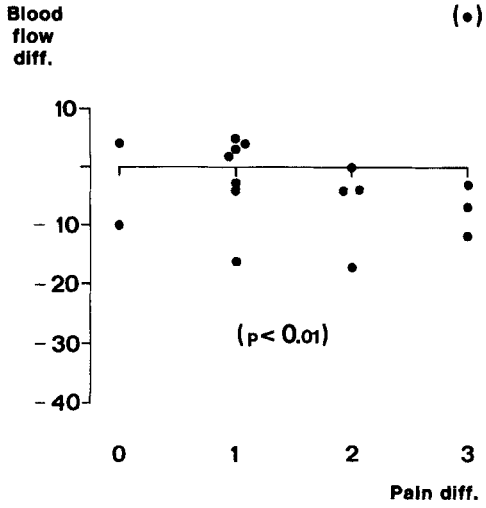

Figure 2. Scatter diagram showing the correlation between pain (expressed as pain difference between the two shoulders) and blood flow (expressed as side difference between the right and left trapezius muscle) of the exposed muscle fascia with underlying muscle tissue ($P < 0.01$). The value within parentheses was excluded.

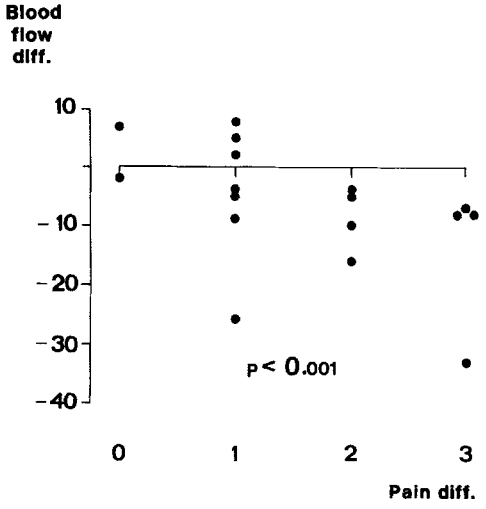

Figure 3. Relationship between pain and blood flow (both expressed as side differences) directly on the muscle surface at habitual rest ($P < 0.001$).

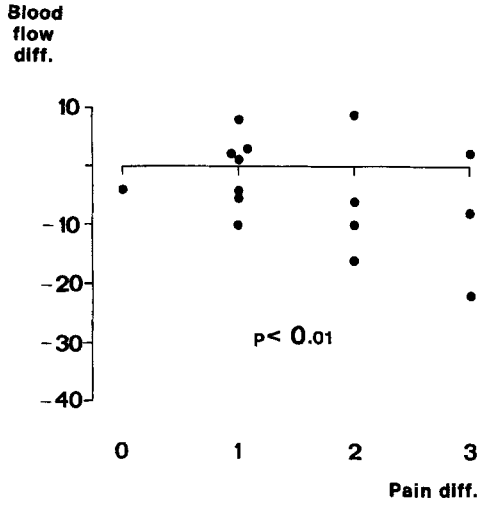

Figure 4. Muscle blood flow during isometric contraction and relation to pain, $P < 0.01$ (see text of Figures 2 and 3 for explanation).

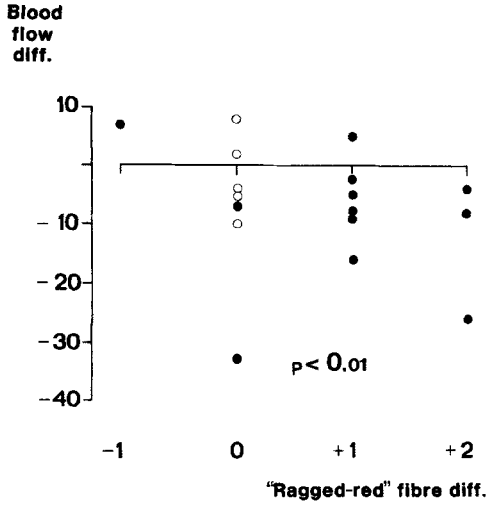

Figure 5. Presence of ragged red fibers (● present, ○ not present) and blood flow (both expressed as side differences). There was a significant relationship between reduced blood flow and the presence of ragged red fibers and the presence of pain as well ($P < 0.01$).

one side. Two patients had bilateral pain of equal degree, and 15 had pain dominating on one side—all on the side that had been most exposed to a static load at work.

The blood flow was expressed as the difference between the recordings of the most painful side minus that of the opposite side. A negative difference meant that the blood flow was less on the most painful side compared with the other side, i.e., reduced. In that way, pain, as well as the presence of ragged red fibers, could be correlated with the difference in blood flow. For that reason, the extent of ragged red fibers was also expressed as the difference between the most painful side and the opposite side: 0 = no side difference; +1 = slightly more changes on the most painful side; +2 = definitely more changes on

the most painful side; and, finally, –1 = changes preferentially located on the less painful side. The presence of ragged red fibers was assessed by one of us (KGH) without any knowledge of the patients' anamnesis. Several of the serially cut sections were examined in each biopsy for the assessments.

For the statistical analyses, Wilcoxon's signed rank test was used as well as Spearman's rank correlation coefficient and regression analysis. $P < 0.05$ was considered significant.

Results

Changes in the interfibrillary network (mitochondria and sarcoplasmic reticulum) giving the fiber a moth-eaten appearance were seen uniformly distributed over the cross section and to the same extent on both sides except in 2 patients who had most pronounced abnormality located on the most painful side. Ragged red fibers (Figure 1) were found in 12 of the 17 patients. The changes were confined to the Type 1 fibers. Two patients had ragged red fibers of equal occurrence on the two sides. Of the 10 patients with side differences, 9 patients showed pathology predominantly on the most painful side ($P < 0.05$).

With no side difference, slightly abnormal muscle fibers were observed showing internally situated nuclei, isolated atrophic fibers, a slight variation of fiber diameter, and occasional signs of splitting of muscle fibers. In 2 of these cases, the atrophy was confined to the Type 2 fibers and on the most painful side.

The recordings of the blood flow gave consistently lower values for the subcutaneous fat compared with the muscle.

The recordings made of the fascia with underlying muscle showed throughout considerably higher values as compared with the recordings made directly on the exposed muscle surface. Figure 2 shows the correlation between pain and blood flow recorded on the exposed muscle fascia with underlying muscle tissue. One highly deviating value (within parentheses) was excluded because, in view of the precision of the method, the recordings had most probably been made including a large artery. Pain was correlated with reduced blood flow.

A corresponding scatter diagram (Figure 3) shows the relationship between pain and blood flow recorded directly on the muscle surface at habitual rest. Pain was correlated with reduced blood flow. A scatter diagram (Figure 4) of the muscle blood flow during isometric contraction and pain showed a similar appearance to that obtained at habitual rest, the relationship between pain and reduced blood flow being significant. For muscle blood flow recorded at postcontraction relaxation and pain, a scatter diagram was obtained with a similar appearance to the two previous ones; however, the differences were not significant ($0.05 < P < 0.10$).

The relationship between pain and the presence of ragged red fibers, as well as blood flow, is shown in Figure 5. Five patients showed no ragged red fibers at the bilateral examination, whereas 2 cases had ragged red fibers to the same extent bilaterally. There was a relationship between reduced blood flow and the presence of ragged red fibers, as well as the presence of pain.

Discussion

Two types of changes in the interfibrillary network (mitochondria and sarcotubular system) were found in biopsies from the trapezius muscle. The moth-eaten appearance indicates a changed distribution of mitochondria and/or a sarcotubular system. This phenomenon did not show any difference between the two sides. In the trapezius muscle moth-eaten fibers can occur also in individuals who do not have muscular pain or muscular fatigue. The Type 1 fibers that have a moth-eaten appearance are larger than fibers that have a normal appearance. This indicates that the moth-eaten appearance is related to load and that this load is great enough to cause an increase in muscle fiber volume (Bengtsson et al. 1986).

The second finding, that of ragged red fibers, is the hallmark of a mitochondrial myopathy. In our previous report (Larsson et al. 1988), we found ragged red fibers in biopsies from the trapezius muscle more frequent than in healthy controls in patients with chronic work-related local myopathy.

A correlation was found between the degree of myalgia and the side having been most exposed to a static load. As to the presence of ragged red fibers, the difference was in the same direction as the pain difference in 9 out of 10 cases. Ragged red fibers are not specific for a certain pain syndrome, but the finding indicates a disturbance in the energy-producing system. In the upper part of the trapezius, ragged red fibers can be found also in the absence of pain. Our results indicate a relation between pain and the occurrence of ragged red fibers, and this relation may be quantitative rather than qualitative.

There are some difficulties involved in quantifying ragged red fibers. The typical appearance is segmental and can easily be missed if only a few sections are examined. Although the majority of the patients had long-term absence from work due to their complaints, we cannot conclude that the observed mitochondrial damage is irreversible, nor that this might cause the local pain. The observed mitochondrial pathology of the Type 1 fibers appeared to be very localized to certain segments of the fiber. Nevertheless, biochemical analysis of the whole biopsy demonstrated a drop in ATP and ADP, lactate values being normal (Larsson et al. 1988).

Öberg et al. (1979) were the first to report on the measurement of microvascular blood flow in skeletal muscle. Later, several groups have compared this method with other methods for muscular blood flow measurements (Salerud and Öberg 1987, Tashmonsk et al. 1983, Holmström and Lewis 1983, Tymol and Ellis 1985). Our findings strongly support the hypothesis that local muscle pain might be related to local, temporary hypoxia causing a limited energy crisis within the fiber. The actual work posture with the arm kept in a position of 45° abduction and 45° flexion and the elbow at a straight angle has been calculated at 18 percent of the maximum muscle strength in the average female assembly worker (Kvarnström 1985). Very likely, this might have caused the local impairment of the capillary blood flow that we have demonstrated. Not only was the blood flow less on the side with most pain, the reduction of blood flow was also related to increased pain. The pain and the reduction in blood flow prevailed despite long-term absence from the static load at work. This might suggest a more or less persisting disturbance of mechanisms regulating local muscle blood flow. These effects might be exerted at the precapillary level causing a shift in the distribution of the capillary blood flow or perfusion of the muscle.

The hypothesis is consistent with the very localized mitochondrial changes confined to Type 1 fibers.

Acknowledgement

This work was supported by grants from the Swedish Work Environment Fund, Stockholm, project no. 87-0788.

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