Trapezius muscle changes unrelated to static work load

Chemical and morphologic controlled studies of 22 women with and without neck pain

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From a cross-sectional study of 82 women who were engaged in assembly work that involved static muscle loading of the shoulder muscles, 11 cases with complaints of neck tension (all except 1 arising at work) and 11 individually matched, exposed control cases without neck pain were studied. In addition, 10 matched, unexposed control cases were studied. Upon histochemical examination and study of the trapezius muscle, morphologic changes of type ragged red fibers were found in 8/11 neck-pain cases, in 7/11 exposed controls, and in 4/10 unexposed controls. The pathologic and clinical importance of rare, ragged red fibers in the trapezius muscle thus seems uncertain.

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Work-related neck pain is common in several occupational groups (Waris 1980, Hagberg and Wegman 1987). Work-related neck pain is characterized by pain upon palpation of neck muscles and a sense of stiffness in the neck during movements (Hagberg and Kvarnström 1984, Hagberg and Wegman 1987). Several studies have shown that the trapezius muscle is exposed to extended static loading in some monotonous work tasks, and there is an extra risk of contracting chronic neck pain in this type of work (Hagberg and Wegman 1987, Ohlsson et al. 1989).

Recent studies have reported morphologic (ragged red fibers), biochemical (ATP depletion), and bloodflow (reduced) changes in the trapezius muscle of women on long-term sick-leave for chronic work-related neck pain compared with healthy controls (Larsson et al. 1988, 1990).

The pathophysiologic mechanisms underlying the described changes of the muscle are unclear.

We have studied whether or not a chronic static load on the neck muscles causes histopathologic changes of the trapezius muscle in persons who have developed pain, but also in persons who have not developed pain.

Patients and methods

11 women with the diagnosis *neck tension* who were employed in highly repetitive, short cyclic assembly work and 11 women who were engaged in the same type of work but who did not have neck pain were studied; both groups were selected from a cross-sectionally examined group comprising 82 women who were employed at the same company and who were all performing the aforementioned work tasks. The control group comprised 10 age-matched, healthy, hospital-employed women who had not been engaged in similar work tasks. The work of the control group did not involve computor-terminal work, microscope work, cleaning, or heavy lifting. All the healthy persons participating in the study had given their written consent, and the study was approved by the local hospital's ethics committee.

The diagnosis neck tension was based on reported neck pain, sense of fatigue or stiffness in the neck, frequent headache radiating from the neck, tightness in the trapezius muscle, and general or local tenderness of the trapezius muscle, as well as tenderness upon palpation where the neck muscles attach to the cervical vertebrae. The two groups occupied in assembly work were individually matched according to age and employment period. Consideration was taken whether or not the examined women had been working full or part-time. The mean period of employment in the two groups—those with and those without neck pain—was respectively 14 years and 13 years. All of those examined in the exposed group had had similar work tasks and few technical changes had occurred at the actual work places during all of their employment period. The mean age in the three groups was 48 (24–64) years. All the participants, except for 1 woman who had been on sick-leave for 1 year due to neck pain, were at work when the examination was made. The mean duration of pain in the group with neck tension was 9 years. In this group, several women reported pain from primarily the shoulders, but even in the elbows and hands. No one fulfilled the suggested criteria for primary fibromyalgia (Yunus et al. 1981), nor did anyone have physical signs of articular disease. In the two other groups, no complaints from the musculoskeletal system were reported.

Everyone that was included in the study was clinically euthyroid. Hemoglobin values, leukocytes, thrombocytes, liver enzymes, creatinine, calcium, and creatine kinase were normal in all the women. Antinuclear antibodies were positive in low titers in 3 women in the control group, in 1 woman in the exposed group without neck pain, and in 2 women in the group with neck tension. Rheumatoid factor was present in 1 woman with neck tension. In the control group, all had normal thyroid laboratory parameters. In the exposed group without neck pain, 1 woman had a slightly elevated thyroid stimulating hormone (TSH) value. In the group with tension neck, 3 women had slightly elevated TSH, but normal T3 and T4 values. In the latter group, 2 women had decreased TSH, whereas 1 of them had normal T3 and T4 values, and the other had elevated T3 and T4 values.

Muscle examinations

Open muscle biopsies were taken from the descending part of the right trapezius. The incision was placed between the seventh process of the cervical spine and the lateral part of the right acromion process. The skin and subcutaneous tissue were infiltrated with 5 percent Xylocaine. The muscle and the muscle fascia were not infiltrated. Directly after excision, the piece of muscle was put on a saline-humified filter paper in a covered Petri dish. As soon as possible, within minutes, the muscle tissue was prepared under a dissecting microscope. For the histochemical investigation, cross-oriented muscle fibers were cut with a razor-blade and mounted in tragacanta medium on a piece of cork and frozen in isopentane cooled by a mixture of dry ice and ethanol. In addition, thin bundles of muscle fibers were dissected out, mounted slightly stretched on a piece of plastic resin (Sylgaard), and fixed for at least 6 h in glutaraldehyde (4 percent in 0.1 M cacodylate buffer, pH 7.5). After fixation, the specimens were washed overnight in cold 0.1 M cacodylate buffer. Small superficial pieces of muscle were cut out with a razor-blade, postfixed in osmium-ferrocyanide, dehydrated, and embedded in Polarbed 812 for electron microscopy. Semithin light-microscopic sections (cross- and longitudinal) were inspected by phase-contrast light microscopy, and ultrathin sections from selected fibers were cut on a diamond knife ultramicrotome (Juniper Ultramicro). Ultrathin sections were contrasted on the grids with uranyl acetate and lead citrate and inspected in a Jeol CX-100 electron microscope.

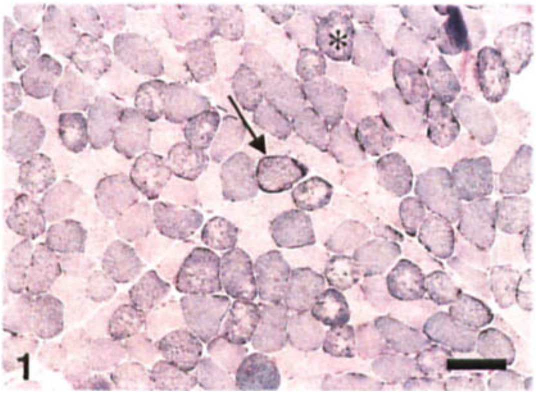
A histochemical examination of frozen specimens included the following stainings: H&E, Gomori-trichrome, NADH-TR, phosphorylase, PAS, lipids, acid phosphatase and myosin-ATPase (alkaline and acid preincubation).

Results

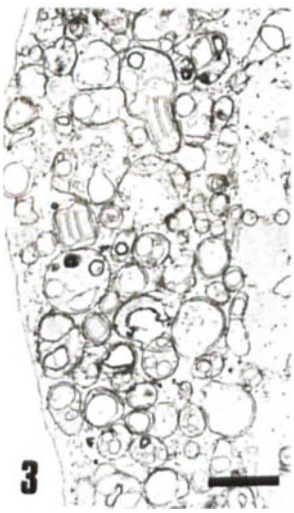
Histochemical staining of myosin-ATPase showed normal fiber-type distribution without fiber-type grouping in all the biopsies. Atrophy of Type 2 fibers occurred to a slight degree in 1 woman in the control group and to a moderate degree in 1 of the women who was exposed, but who had no neck pain. In other respects, there were no differences between the fiber diameters in the three groups as judged by visual inspection. One small cluster of interstitial lymphocytes was found in one of the biopsies from the control group. None of the muscle biopsies showed any appreciable increase in the number of centrally located nuclei, degeneration, necrosis, or regeneration of muscle fibers.

So-called moth-eaten Type 1 fibers characterized by irregular and multifocal disruption of the intermyofibrillar network when stained for oxidative enzymes (NADH-TR) occurred in a moderate to high number of Type 1 fibers in all the biopsies. So-called ragged red fibers, characterized by intermyofibrillar and especially subsarcolemmal mitochondrial aggregates seen as red granular deposits in modified Gomori trichrome staining, were found sporadically in 8 women with neck tension. Among exposed women without neck pain, ragged red fibers were found in 7 and in the control group in 4 women.

An ultrastructural examination of ragged red fibers in 1 women (exposed without neck pain) revealed an abundant accumulation of mitochondria, especially with subsarcolemmal location, and some mitochondria with pathologic inclusions (Table 1, Figure 1).

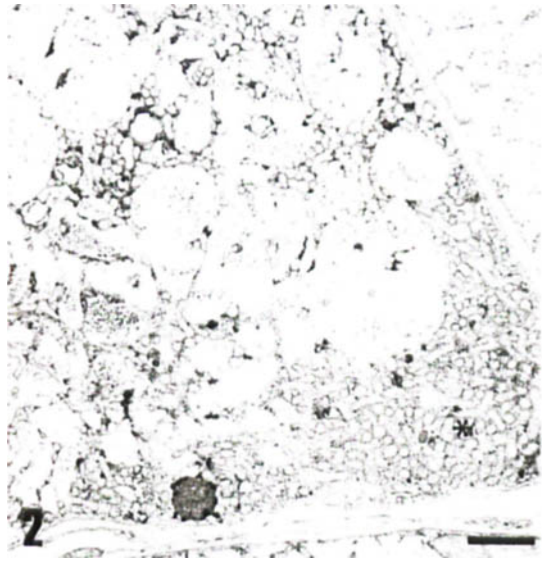


Numerous type 1 fibers with moth-eaten appearance (asterisk) and one ragged red fiber (arrow) can be seen. NADH-TR staining. Bar = 100 μm.



Subsarcolemmal mitochondria: some of which have pathologic cristae and inclusions. Bar = 1 μm.

Figure 1. Frozen cross-section of trapezius muscle from a woman exposed to static muscle loading without pain.



Low-power, cross-section electron micrograph showing a ragged red fiber with an accumulation of mitochondria under the sarcolemma (asterisk). Bar = 2 μm.

Discussion

The ragged red fiber is a hallmark for a mitochondrial myopathy when abundantly present in a muscle biopsy (Swash et al. 1978, Morgan-Hughs 1986). Occasional ragged red fibers may be found in muscle biopsies from patients with diverse neuromuscular conditions (Black et al. 1975, Swash et al. 1978, Morgan-Hughs 1986), including so-called primary fibromyalgia (Yunus et al. 1981, Bengtsson et al. 1986). Ragged red fibers have also been associated with muscle degeneration and regeneration (Reznik and Hansen 1969),

Table 1. Age, length of employment (years), and histochemical findings in biopsies of the trapezius muscle in two groups of women employed in the assembly industry and a control group

Control group				Exposed women with neck pain					Exposed women without neck pain				
Age	A	B	C	Age	Employment	A	B	C	Age	Employment	A	B	C
26	–	–	–	24	5	+	–	–	26	5	–	–	–
34	–	–	–	36	15	–	–	–	34	19	–	–	–
42	–	–	–	42	23	+	–	–	40	22	–	–	–
45	+	–	–	47	11	–	–	–	44	27	+	–	–
47	–	–	–	48	29	–	–	–	45	25	+	–	–
52	+	+	+	48	16	+	–	–	45	17	+	–	–
52	–	–	–	56	15	+	–	–	52	15	+	–	–
56	–	–	–	57	25	+	–	–	53	23	+	–	++
59	+	–	–	58	30	+	–	–	57	27	+	–	–
59	+	–	–	58	22	+	–	–	63	15	++	–	–
				61	18	+	–	–	64	40	–	–	–

A Ragged red fibers, B Occasional lymphocytes, C Atrophy of Type 2 fibers, + Rare, ++ Moderate.

acute ischemia (Heffner and Barron 1978), and microangiopathy (Sengers et al. 1986).

Larsson et al. (1988) found ragged red fibers in the trapezius muscle in patients with work-related chronic myalgia but not in healthy controls. This research group (Larsson et al. 1990) has reported that isolated pathologic ragged red fibers are related to the presence of pain and that myalgia was correlated with reduced blood flow.

In our material, ragged red fibers occurred in all three groups. A proportion of Type 1 fibers with a moth-eaten appearance were equally present in all the biopsies. It is interesting that ragged red fibers were present in as many as 4 out of 10 healthy individuals. Therefore, the presence of ragged red fibers in the trapezius muscle need not be a truly pathologic sign, but merely represents a normal variant of this muscle.

The occurrence of ragged red fibers was more conspicuous in both groups that were exposed to a long-term static muscle load. Because there was no difference between the two exposed groups, a connection between chronic pain and the occurrence of ragged red fibers cannot be made. However, a quantitative relation between ragged red fibers and muscle pain, as stated by others (Larsson et al. 1990), cannot be ruled out because of the limited number of subjects that were included in our series. However, due to the age and the employment matching that were made, it is unlikely that women in the exposed group without complaints, but with ragged red fibers in their trapezius muscle, will develop neck pain. The specimen with the most frequently present ragged red fibers came from a woman who did not report any neck pain, although her neck muscles for 40 years had been exposed to frequent and long-term static muscle loads (Figure 1).

A relation between ragged red fibers and changes in microcirculation seems reasonable in view of the influence on blood flow that arises during static muscle work (Sjögaard et al. 1986, Larsson et al. 1990). The results presented in our study do not invalidate the hypothesis that nociceptive muscle pain (and ragged red fibers) develop from temporary hypoxia and from an energy crisis within some muscle fibers caused by a long static muscle load with compromised muscle blood flow (Larsson et al. 1990).

The trapezius muscle is normally exposed to a static muscle load, but the reason why only some persons develop muscle pain is unclear. The presence of isolated ragged red fibers in this muscle should not be used as a diagnostic criterion for any pain syndrome.

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