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Cardiovascular and muscle activity during chewing in whiplash-associated disorders (WAD)

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ABSTRACT

Objective: The present study aimed to elucidate possible physiological mechanisms behind impaired endurance during chewing as previously reported in WAD. We tested the hypothesis of a stronger autonomic reaction in WAD than in healthy subjects in response to dynamic loading of the jaw–neck motor system.

Design: Cardiovascular reactivity, muscle fatigue indicies of EMG, and perceptions of fatigue, exhaustion and pain were assessed during standardised chewing. Twenty-one WAD subjects and a gender/age matched control group participated. Baseline recordings were followed by two sessions of alternating unilateral chewing of a bolus of gum with each session followed by a rest period.

Results: More than half of the WAD subjects terminated the test prematurely due to exhaustion and pain. In line with our hypothesis the chewing evoked an increased autonomic response in WAD exhibited as a higher increase in heart rate as compared to controls. Furthermore, we saw consistently higher values of arterial blood pressure for WAD than for controls across all stages of the experiment. Masseter EMG did not indicate muscle fatigue nor were there group differences in amplitude and mean power frequency. Pain in the WAD group increased during the first session and remained increased, whereas no pain was reported for the controls.

Conclusion: More intense response to chewing in WAD might indicate pronounced vulnerability to dynamic loading of the jaw–neck motor system with increased autonomic reactivity to the test. Premature termination and autonomic involvement without EMG signs of muscle fatigue may indicate central mechanisms behind insufficient endurance during chewing.

1. Introduction

Previous experimental and clinical studies suggest that there is a close functional linkage between the jaw and the neck sensory–motor systems in jaw activities (for reference Eriksson et al.).[1] Recent studies from our laboratory have shown well coordinated concomitant mandibular and head–neck movements during single as well as rhythmical jaw opening–closing

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tasks, suggesting that recruitment of neck muscles and head–neck movements are an integral part of natural jaw functions.[2,3] Given that jaw opening–closing involves also the cervical region, traumatic neck injury is expected to hamper jaw function. This hypothesis was supported by studies on jaw function in patients with whiplash-associated disorder (WAD) which showed smaller amplitudes and a disturbed coordination pattern of head and mandibular movements compared to healthy subjects.[4–6] Furthermore, a previous study in WAD[7] showed markedly reduced endurance during dynamic loading of the jaw–neck motor system by means of a standardised chewing test. In that study the control subjects completed the test, whereas the majority of the WAD subjects terminated the test prematurely due to fatigue, exhaustion and/or pain. Impaired endurance during chewing may be interrelated with eating difficulties and changed food habits as previously reported by WAD subjects.[8]

The mechanisms behind impaired endurance during chewing in WAD are unclear. Studies in chronic muscle pain patients have indicated possible involvement of the autonomic nervous system in terms of changes in cardiovascular neural control, particularly enhanced activity of the sympathetic system. Results are rather consistent in patients with widespread pain (e.g. fibromyalgia),[9–12] but ambiguous in localised pain states.[12,13] Previous findings in healthy subjects of a distinctive cardiovascular response to jaw clenching[13] and chewing[14,15] suggest that isometric and dynamic jaw actions evoke significant autonomic reactivity. From observations in WAD patients of symptoms like sweating, heart palpitation and nausea provoked during a standardised chewing test (unpublished data) we assume that WAD is associated with increased ANS reactivity in response to dynamic loading of the jaw–neck motor system.

However, studies of autonomic reactivity in response to a dynamic loading of jaw–neck motor system in WAD are currently lacking.

The present study aimed to elucidate possible physiological mechanisms behind the impaired endurance during chewing as previously reported in WAD.[7] A primary aim of the present study was to test the hypothesis of a stronger autonomic reaction in WAD subjects than in healthy subjects, in response to dynamic loading of the jaw–neck motor system. Changes in electromyographic (EMG) activity are often used as physiological indicators of muscle fatigue. This is generally depicted as an increase in the signal amplitude and concomitant decrease in frequency components. Thus, we assessed in WAD subjects and healthy matched controls objective measurements of cardiovascular reactivity and muscle fatigue, i.e. masseter electromyographic (EMG) recording, as well as subjective measurements of fatigue, exhaustion and pain during standardised chewing.

2. Materials and methods

2.1. Subjects

Forty-two subjects participated in the study. In the WAD group there were 21 subjects (15 females, 6 males, 39.0 ± 8.3 years of age). The WAD individuals had typically developed head–neck–shoulder pain, impaired and painful head–neck movements and tender neck muscles, and had been suffering for between 3 and 13 years. They were referred to the department of Clinical Oral Physiology at Umeå University Hospital (Sweden) for assessment and management of longstanding (more than 6 months) jaw-face pain and impaired and painful mandibular movements that had developed following the neck–head trauma. The inclusion criterion was jaw-face pain of muscular origin, Group I, Axis I, according to Research Diagnostic Criteria.[16] An exclusion criterion was temporomandibular joint disorder. The clinical examination, performed by one of the authors (P-O.E.), showed marked tenderness or pain to palpation above the jaw closing and opening muscles, face muscles and neck–shoulder muscles. The examination additionally revealed disturbance of balance, dizziness tinnitus, hyperacusis, cognitive, sleep and visual disturbances, feeling tense and general tiredness, headache and neck, shoulder and low back pain in nearly all WAD subjects. They were primarily diagnosed by a physician and the trauma had resulted in WAD grade II or III according to the Quebec Task Force classification.[17] In this classification grade I stands for neck pain but no signs, grades II and III neck pain with musculoskeletal signs and neurological signs, respectively, and grade IV neck pain and fracture. However, based also on findings of disturbed trigeminal nerve sensory function, all WAD individuals fulfilled the criteria for WAD III. Additionaly, subjects were examined by one of the authors (MN) for pressure pain in other body regions and it was observed that under palpation WAD subjects had pain at multiple sites.

The control subjects (15 females, 6 males, 38.7 ± 8.1 years of age, i.e. age and gender matched to the WAD group) were recruited among Umeå University staff members. They were confirmed to be without pain and disorders in the neck and jaw-face, also via clinical examination. Ethical approval was obtained from the Ethics Committee of Umeå University. Informed consent following detailed introduction to the experiment was obtained, and utmost care was taken not to worsen the symptoms that the WAD subjects had reported. The decision for early termination of the experiment at any given time was at the subjects' discretion.

2.2. Experimental procedure

The experiment consisted of five stages. Following electrode and sensor positioning and familiarisation with the laboratory surroundings, the first stage entailed a 5-min baseline recording. For this stage the subjects sat quietly. The second stage involved the first chewing test that was 5 min in duration and was performed on the subject's preferred chewing side.

The subjects were instructed to use ''the preferred chewing side'', meaning the side in the test situation which the subject found least inconvenient/painful for chewing. By this procedure we intended to keep down provocation of pain and exhaustion, and avoid the subjects early termination of the test, before chewing on both sides.

This was followed by a 5-min recovery period, which constituted stage three. Next a similar chewing test was done on the opposite side (stage four). Stage five incorporated recovery for 5 min following the second chewing test. After this the experiment ended.