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New objective findings after whiplash injuries: High blood flow in painful cervical soft tissue: An ultrasound pilot study

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HIGHLIGHTS

- Painful neck regions in patients with whiplash-associated disorder were studied.
- Grey scale ultrasound and colour Doppler were used to confirm high blood flow.
- Whiplash patients had higher blood flow compared with the control subjects.
- High blood flow was found in painful regions of the neck in whiplash patients.

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ABSTRACT

Background: The presence of high blood flow in the structurally abnormal and painful regions of tendinosis, but not in the normal pain-free tendons, was recently confirmed by colour Doppler (CD) ultrasound (US). Biopsies from the regions with high blood flow demonstrated the presence of sympathetic and sensitive nerve fibres juxtapositioned to neovessels. Grey-scale US and CD are reliable methods used to evaluate structural homogeneity, thickness, and blood flow in the peripheral tendons. The aim of this study was to utilize CD to qualitatively evaluate for the presence of abnormal high blood flow in paravertebral tissues after whiplash injuries in patients with chronic neck pain.
Methods: Twenty patients with chronic neck pain after whiplash-associated disorder (WAD) and 20 pain-free control subjects were included in the study. The same experienced radiologist performed all grey-scale US and CD examinations.
Results: More regions with high blood flow were observed in the patient group than in the control group. At all levels, the high blood flow pattern was detected at the enthesis of the spinous processes and bilaterally juxtapositioned to the facet joints.
Conclusion: All regions identified by the patients as painful and tender corresponded to the positive high blood flow found during the CD examination.
Implications: These findings document increased blood-flow/neovascularisation at insertions of neck muscles which may indicate that there are pathological neovascularisation with accomanying pain- and sympathetic nerves, similar to what has been found in Achilles-tendinosis. These findings promise that similar treatments that now is successful with Achilles tendinosis, may be effective in the WAD-painful muscle insertions of the neck.

1. Introduction

In Western countries, whiplash injuries are a major health problem because of their high prevalence [1,2] and increasing economic costs [3,4]. The incidence varies from 1.0 to 3.2/1000 per year [5]. The prevalence of long-term symptoms after whiplash injuries varies. Mayou et al. reported that 35% of patients suffered physical problems 5 years after the injury [6]. Others reported persistent

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neck pain in 84–90% of patients 1–2 years after the injury [7], or in as much as 50% of patients 17 years after the injury [8].

Although many patients after whiplash trauma recover within a few months after the accident, a significant proportion continues to suffer from prolonged symptoms [5,9]. The injury may lead to a variety of clinical symptoms known as whiplash-associated disorder (WAD) [10], and the conditions after WAD can affect the activities of daily living, work, and leisure [11,12].

The pathogenesis of soft-tissue pain after whiplash injury is largely unknown, and several studies have failed to show pathology in the muscles and ligaments of the neck [13–15].

Recent studies of chronic painful Achilles and patellar tendons, using grey scale ultrasound (US) and colour Doppler (CD), confirmed the presence of high blood flow in the structurally abnormal tender and painful regions of such tendons, but not in the normal pain-free tendons [16,17]. Studies on biopsies taken from the region with tendon changes and vascular ingrowths have confirmed nerves in close relation to blood vessels [18,19], and injections of local anaesthetic in the regions with neovessels temporarily abolished the patient's pain [20]. Grey scale US and CD are reliable methods to evaluate the structure, thickness and blood flow in the Achilles and patellar tendons [21–24].

The knowledge of the pathogenesis and pathomechanisms behind WAD is lacking. Attempts at the diagnosis and treatment of painful cervical tendinopathies after whiplash injuries have been described since 1950s [25–31]. The only objective findings are the presence of tenderness that is relieved after local anaesthetic infiltration.

Recent findings suggest the presence of persistent paravertebral tissue inflammation in cervical soft tissue in patients with chronic pain after whiplash injuries [32].

More recent publications have disclosed the presence of abnormal blood flow in myofascial trigger points [33].

The aim of this cross-sectional, single-blinded, comparative study was to use US and CD to evaluate the presence of abnormal high blood flow in the painful neck regions in patients with chronic pain after whiplash injury.

2. Materials and methods

2.1. Participants

Twenty patients (10 men and 10 women) aged 39.1 ± 9.9 years (mean ± SD) with chronic neck pain from WAD (more than 2 years after injury) were included in the study. Patients were recruited through an internal announcement in the outpatient clinic of the Department of Community Medicine and Rehabilitation, Umeå University Hospital. All patients had sustained their injuries in a vehicle accident. Plain radiographs were obtained on all patients and magnetic resonance imaging (MRI) was obtained on 12 patients. The imaging did not show abnormal findings. The control group comprised 20 healthy subjects (10 men and 10 women) aged 39.9 ± 9.7 years, with no a history of whiplash injury or neck pain, MRI, or radiographic evaluation. Pain intensity was assessed using the visual analogue scale (VAS). The Disability Rating Index (DRI) was used to assess the level of activity. An additional questionnaire included in the Swedish Quality Registry for Pain Rehabilitation was used to assess pain and associated days lost from work.

2.2. Study design

A cross-sectional, single-blinded, comparative pilot study. The examiner was aware if the subject was a patient or control, but he was not aware of the localization or intensity of pain in patients.

2.3. Visual Analogue Scale

The Visual Analogue Scale (VAS) measures pain intensity [34]. Patients mark their experienced pain on a 100-mm-straight line, where 0 means "no pain" and 100 "worst pain imaginable." Pain intensity was marked at the time of assessment (pain now) and pain intensity during the last week.

2.4. Disability Rating Index

The Disability Rating Index (DRI) is a clinical research instrument that measures the extent of physical disability (12 items). It covers activities ranging from basic activities (such as dressing and walking) to work-related activities (such as lifting). Patients rate their perceived ability to perform the activities on a 100-mm visual analogue scale, from 0 (no disability) to 100 (inability to perform at all). The distance is measured in mm and an index is obtained. The mean value provides the DRI-index. The DRI has shown acceptable reliability and validity [35].

2.5. Grey-scale ultrasound

The US examination was conducted with the patient in the sitting position with the head slightly flexed forward. It was performed with an Acuson S2000 (Siemens), using a curved 6–2 MHz probe (6C2) in the harmonic imaging mode.

The examination was done systematically, beginning at the nuchal lines on each side, followed by C1 on the right side, then midline and C1 on the left side, followed by C2 on the right side, the spinous process, and C2 on the left side, and thereafter C3–C7 in the same manner.

2.6. Colour Doppler

For the CD examination, the CD velocity technique was used, where the colour of the flow indicated the direction and velocity of the blood flow. The intensity of high blood flow/neovascularisation was graded on a 3-point scale: 0 = 0 vessels, 1 = 1 to 2 vessels, and 2 = 3 vessels or more. All US and CD examinations were done by the same experienced radiologist, and the grading was done by 2 individuals. There was no disagreement in the grading process.

2.7. Ethics

The study was approved by the regional committee for medical research ethics, the Regional Ethical Review Board of Umeå University (Dnr:04–157 M) and informed consent was obtained from each participant.

2.8. Statistical methods

All statistical analyses were performed with SPSS (version 17.0) for Windows. Data were reported as means ± standard deviations unless indicated otherwise. Comparisons of pain intensity, the level of disability, and areas of increased/high intensity blood flow between patients and the control group were made using the Mann–Whitney *U* test. Chi-square-test was used for the comparison of proportions between the groups. The statistical significance level was set at 0.05.

3. Results

3.1. Participants

Eleven patients were working full time, 3 were on sick leave, 3 had disability pension, 2 were unemployed, and 1 was on parental