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Clinical Paper
TMJ Disorders

Local application of Aqua Titan improves symptoms of temporomandibular joint muscle disorder: a preliminary study

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Abstract. Aqua Titan (AT), comprising microscopic titanium particles dispersed in water, has been reported to have beneficial effects on muscle tissue. This study investigated the effects of local application of AT on symptoms in patients with muscle disorders of the temporomandibular joint (TMJ) compared to patients with joint disorders of the TMJ. Sixteen patients with unilateral masseter muscle pain during motion (muscle disorder group) and six patients with unilateral TMJ pain during motion (joint disorder group) applied an AT-permeated patch over the painful area every night for 2 weeks. Symptoms were evaluated clinically at the initial visit and 1 and 2 weeks later. Clinical symptoms in the joint disorder group showed no tendency towards improvement after 2 weeks. In contrast, mouth opening range with/without pain, visual analogue scale (VAS) scores for pain during mouth opening and eating, and activities of daily living (ADL) scores in the muscle disorder group were improved significantly after 2 weeks. Multiple comparison tests in the muscle disorder group showed significant improvements in the VAS for eating and ADL score after 1 week. These results suggest that the AT patch has a potential supplementary role in the treatment of patients with muscle disorders of the TMJ.

Key words: Aqua Titan; temporomandibular disorder; muscle pain; masseter muscle.

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Temporomandibular disorders (TMDs) are the most common cause of orofacial pain after toothache.[1] Symptoms of TMD include pain, joint noise, and disturbance of jaw movement, and patients often show a broad range of symptoms, such as neck muscle pain and headache.[1] The aetiology of TMD is complex and the pathology is considered multifactorial.[2] Based on the background of TMD pathology, research diagnostic criteria (RDC)/TMD and diagnostic criteria (DC)/TMD are used for research and clinical practice to evaluate patients with TMD.[3,4] In general, the two main types of TMD are joint disorders and muscle disorders.[4] Joint disorders include internal derangement and degenerative joint disorders.

Conservative treatments such as physiotherapy, including lifestyle guidance, are recommended for both disorders in

the early stages.[5] Invasive treatments such as surgery to the temporomandibular joint (TMJ) may be indicated for patients with severe joint disorders after non-surgical treatments.[6] Physiotherapy such as muscle massage and stretching exercises are recommended and are useful for patients with muscle disorders, but results depend on the autonomy and motivation of the patient. Despite being informed and supposedly understanding that TMD is a self-limiting disease, some patients may be dissatisfied with the slow pace of symptom resolution.

Titanium has been reported to have beneficial physiological effects, such as anti-inflammatory, anti-tumour, and anti-oxidant effects, and the stimulation of nerve cell growth.[7–10] Aqua Titan (AT) is a material comprising microscopic titanium particles dispersed in water, achieved through a processing technology developed by Phiten Co. (Kyoto, Japan). AT can be applied to many products in collaboration with other materials to promote health in daily life, and has received attention recently in a variety of fields. Some players in Major League Baseball have used AT-permeated necklaces and undershirts, and these items are considered to improve muscle force, instantaneous force, and stiffness. This technology is also contributing to medical and nursing care. Some researchers have reported biological effects such as regulation of autonomic nervous activity and a reduction in muscle–tendon stiffness.[11–13]

Nishiyama et al.[14] reported that AT-permeated patches are beneficial in relieving TMD-related pain and improving TMD-related limitations to daily function by local application to the most painful area, including the muscles and joints of patients. Such findings suggest the possibility of local application of AT in the treatment of TMD. Hughes et al.[15] reported that AT-impregnated tape applied to the lower extremity promoted the reflex response and attenuated Achilles tendon stiffness following fatiguing exercise; they suggested that the local application of AT can facilitate restoration of contractile ability in muscle–tendon components following strenuous exercise. Considering these results, AT may be advantageous for enhancing muscle–tendon components and appears to be effective in relieving muscle pain and improving muscle problems. The present study therefore focused on muscle disorders affecting the masseter muscle in patients with TMD, based on the possibility that this innovative technology could help in the treatment of patients with disorders of the masseter muscle.

The aim of this study was to investigate the clinical effects of local AT application on the symptoms of patients with masseter muscle disorders compared to patients with joint disorders of the TMJ.

Materials and methods

Patients

Participants comprised 25 patients who initially visited our department between January and March 2012, and who were diagnosed based on RDC/TMD with TMD and motion pain of either a unilateral masseter muscle or unilateral TMJ area. Exclusion criteria were the following: suspected or diagnosed osteoarthritis; history of facial trauma, luxation, fracture, ankylosis, neoplasm, growth abnormality, or surgery to the TMJ; and systemic arthritides (rheumatoid arthritis, psoriatic arthritis, or gout). Three patients discontinued the study because of symptoms of skin discomfort, and the reasons for dropout were recorded. Finally, 22 patients (five men, 17 women; mean age 43.4 years, range 16–78 years) were included in the present study. Of these, 16 patients were diagnosed with muscle disorders and pain of a unilateral masseter muscle and the remaining six patients were diagnosed with joint disorders showing unilateral TMJ pain. Patient details are given in Table 1.

This study was reviewed and approved by the bioethics committee of the study institute and was performed in accordance with the ethical standards laid down in the 2013 revision of the Declaration of Helsinki. All patients provided written informed consent to participate after receiving a detailed explanation of the study purposes.

Table 1. The two groups of study participants with temporomandibular disorders.

Patient group	*n*	Inclusion criteria	Sex	Mean age (range)
Muscle disorders	16	Unilateral masseter muscle pain during motion	3 males 13 females	42.2 (16–78)
Joint disorders	6	Unilateral TMJ pain during motion	2 males 4 females	44.2 (25–73)

TMJ, temporomandibular joint.

AT patch

The AT patch (Phiten Power Tape Clear; Phiten, Kyoto, Japan), a commercial AT-impregnated polyurethane sheet with acrylic adhesive, sold in sporting goods stores and pharmacies in Japan (Fig. 1), was used for this study. The AT patch is transparent, elastic, thin, and 35 mm in diameter. On the first night, each patient attached an AT patch to the forearm (Fig. 1a). After confirming that no discomfort developed, they attached the AT patch to the painful side of the jaw (area of the masseter muscle) for the 16 patients with a muscle disorder and to the painful side of the TMJ for the six patients with a joint disorder. Each patient slept with an AT patch applied to the skin surface every night for 2 weeks in the absence of any symptoms of discomfort (Fig. 1b and c).

Evaluation

At the initial visit and after 1 and 2 weeks, we recorded the following clinical observations for all participants: (1) maximum range of mouth opening between the upper and lower edges of the central incisors, with and without pain; (2) visual analogue scale (VAS; 0–100) scores for spontaneous pain and pain during mouth opening or eating; and (3) activities of daily living (ADL) score using a questionnaire to evaluate ADL related to TMD (Appendix 1). The ADL questionnaire was made up of 13 questions using a 4-point Likert scale (0–3) and the sum of all question scores was recorded as the ADL score. The worst possible condition of ADL was the maximum score of 39.

Statistical analysis

Improvements in symptoms were analyzed statistically using the Friedman test and the Wilcoxon signed-rank test with Bonferroni correction for multiple comparisons. All statistical analyses were performed using IBM SPSS Statistics version 19 software (IBM Japan, Tokyo, Japan). Values of $P < 0.05$ were considered to indicate statistical significance for the Friedman test and values of $P < 0.017$ were considered statistically significant for multiple comparisons based on Bonferroni correction.

A direct statistical comparison between the muscle and joint disorder groups was not performed because of the significant difference in numbers of patients and differences in baseline clinical symptoms and pathologies between the two groups.