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ORIGINAL ARTICLE

Dynamic magnetic resonance sialography as a new diagnostic technique for patients with Sjögren's syndrome

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OBJECTIVE: To evaluate the clinical utility of dynamic magnetic resonance (MR) sialographic images as a diagnostic tool for patients with Sjögren's syndrome.
METHODS: The morphological findings and various kinds of functional parameters in volunteers on dynamic MR sialographic images were compared with those in five patients with definite Sjögren's syndrome.
RESULTS: On the MR sialographs of all five patients with Sjögren's syndrome, the so-called 'apple-tree appearance' was seen. The difference in two functional parameters using the dynamic MR sialographic data was elucidated between the two groups. The maximum area of the detectable ducts in the group of patients was significantly smaller ($P < 0.001$) than that in the group of volunteers. The ratio of change in the detectable ducts in the group of patients was significantly lower ($P = 0.011$) than that in the group of volunteers.
CONCLUSIONS: Our study suggests that dynamic MR sialographic data in addition to MR sialographic images might be useful for the diagnosis of Sjögren's syndrome.
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Keywords: dynamic; Sjögren's syndrome; MR sialography; salivary gland; function

Introduction

Recently, the evaluation of tissue function using various modalities including magnetic resonance (MR) imaging, computed tomography, positron emission tomography, and ultrasound has become more practical in the medical and dental fields (Matos *et al*, 1997; Kats *et al*, 2003; Punwani *et al*, 2003; Ghosh *et al*, 2004; Morimoto *et al*, 2005a; Nakamoto *et al*, 2005; Vaishali *et al*, 2005). In our previous report, we announced 'dynamic MR sialography' as a new non-invasive diagnostic technique for the functional evaluation of salivary glands in their physiologic state (Morimoto *et al*, 2005a). The technique is similar to the dynamic MR cholangiopancreatography (MRCP) technique, in which images are acquired before and after the administration of secretin. The dynamic MRCP technique visualizes the pancreatic ducts in their physiologic state and monitors the ducts filling with saliva in a time-dependent alternation after citric acid stimulation using dynamic MR sialographic images (Matos *et al*, 1997; Kats *et al*, 2003; Punwani *et al*, 2003; Morimoto *et al*, 2005a). We hypothesized that dynamic MR sialography should have the potential to be clinically applied as a diagnostic tool for the many kinds of salivary gland-related diseases (Morimoto *et al*, 2005a).

Among salivary gland-related diseases, one of the most representative diseases is Sjögren's syndrome (Som and Brandwein, 1996; Ohbayashi *et al*, 1998; Tonami *et al*, 1998). It is characterized by xerostomia and keratoconjunctivitis, which result from dysfunction of the salivary and lacrimal glands (Som and Brandwein, 1996). At the present time, X-ray sialography and radionuclide scintigraphy are included as imaging modalities that have been used for the diagnosis of definite Sjögren's syndrome (Som and Brandwein, 1996; Ohbayashi *et al*, 1998; Tonami *et al*, 1998). However, the significance of MR sialographic images as a morphologic examination for the diagnosis of Sjögren's syndrome has been recognized and it is expected that this technique might replace X-ray sialography (Som and Brandwein, 1996; Ohbayashi *et al*, 1998; Tonami *et al*, 1998; Morimoto *et al*, 2002, 2005b).

Therefore, we evaluated the clinical significance of dynamic MR sialographic images and data for patients with Sjögren's syndrome in the present study. We demonstrate that the functional evaluation of salivary glands using dynamic MR sialographic data could be

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more useful than other techniques for the diagnosis of Sjögren's syndrome.

Subjects and methods

For standardized criteria of dynamic MR sialographic data, we recruited 30 volunteers (15 men and 15 women; mean age, 25.2 years; age range, 22–31 years) with no salivary gland pathology, confirmed both by history and clinical examination. We used the image of a single side of the parotid gland ducts. The side of parotid gland ducts to be imaged was decided in a randomized manner. To get dynamic MR sialographic data from patients with Sjögren's syndrome, we recruited five patients (five women; mean age, 45.2 years; age range, 35–62 years) with definite Sjögren's syndrome satisfying the present criteria (Som and Brandwein, 1996; Fujibayashi, 2004). In brief, in histopathological examinations, positive findings for the invasion of lymphocytes were found in labial mucosa and lacrimal glands. In salivary gland-related examinations, stimulated total salivary flow was lower (< 10 ml in 10 min) and salivary scintigraphy showed delayed uptake, reduced concentration, and/or delayed excretion of tracer. Parotid sialography showed the presence of diffuse sialeclasias (punctate, cavitary, or destructive pattern), without evidence of obstruction in the major ducts. In ocular examinations, the Schimer's test result was < 5 mm in 5 min, and the Rose Bengal score was over 3. Another ocular dye score was positive. Regarding the presence of autoantibodies in the serum, antibodies to Ro/SSA antigens, La/SSB antigens, or both were detected. If the results from two of the four kinds of examinations were positive, the patient was considered to have Sjögren's syndrome. We used the image of a single side of the parotid gland ducts, as in the volunteers. The side of parotid gland ducts to be imaged was also decided in a randomized manner unless the main complaint was limited to one side. The study design was approved by the institutional review board of Kyushu Dental College. Informed consent was obtained from all volunteers before the MR examination.

All images were acquired using a 1.5 T full-body MR system (VISART; Toshiba, Tokyo, Japan) with a circular polarized neck coil to visualize the parotid gland ducts (Morimoto *et al*, 2002, 2004, 2005a,b). T1-weighted, T2-weighted, and two-dimensional fast asymmetric spin-echo sequences (2D-FASE) images were acquired for each subject. The MR imaging parameters used are shown in Table 1. Fat saturation suppressed signal from subcutaneous fat. A previously described method was used for identifying the parotid gland ducts (Morimoto *et al*, 2002, 2004, 2005a,b).

The dynamic MR sialographic images and data were acquired as previously described (Morimoto *et al*, 2000, 2005a). In brief, first, acquisition of the optimal section using 2D-FASE sequencing with single-section acquisition of thick sections was repeated every 30 s (acquisition time: 18 s; interval time: 12 s) before and after a few drops of 5% citric acid were placed on the tongue. Evaluation of the time-dependent increases or decreases in the area of the detectable parotid gland's main ducts, high-intensity linear structures from the parotid glands to the upper first molar region, before and after citric acid stimulation was precisely visualized every 30 s and analyzed from the MR sialographic images (Figures 1a and 2a). Simultaneously, the time from the end of citric acid stimulation to the occurrence of the maximum area of the ducts was measured. This dynamic procedure was conducted during the 8 min after stimulation. The time it took for the parotid gland duct area to return to 50% of its pre-citric acid stimulation level was measured. Evaluation of the time-dependent alternation associated with citric acid stimulation of the area of the detectable parotid gland ducts was quantitatively measured using the scanner-computer analysis system (Morimoto *et al*, 2000, 2005a).

For each subject, a graph was drawn to demonstrate the relationship between the time course after citric acid stimulation and the changing ratio of the detectable area in the parotid gland ducts. The changing ratio was determined as follows: changing ratio = detectable area of parotid gland ducts/minimum detectable area.

As the morphological finding on MR sialographic images of patients, we evaluated whether or not the so-called 'apple-tree-like appearance' was depicted, and the likely characteristic radiologic findings of Sjögren's syndrome on X-ray sialographic images (Som and Brandwein, 1996; Ohbayashi *et al*, 1998; Tonami *et al*, 1998; Kalinowski *et al*, 2002; Morimoto *et al*, 2002, 2004; Baur *et al*, 2004). In concrete, the presence or absence of diffuse areas of punctate high signal intensity 1 mm or less in diameter on MR sialographic images were evaluated (Som and Brandwein, 1996).

Student's *t*-test was used to examine the differences between the volunteers' group and the patients' group on the following: (1) maximum area of the detectable parotid gland ducts before and after citric acid stimulation; (2) changing ratio; (3) time from the end of citric acid stimulation to the occurrence of the maximum area of the detectable parotid gland ducts; and (4) time it took for the parotid gland ducts to decrease from their

Table 1 Magnetic resonance imaging parameters

Sequence	*TR/TE/FA/ETL*	*Thickness (mm)*	*Matrix*	*Acquisition time (min:s)*	*FOV (mm)*
T1WI	500/15/90/37	6	224 × 320	3:30	200 × 200
T2WI	3500/108/90/27	6	224 × 256	3:30	200 × 200
2D-FASE	6000/500/90/148	30–60	512 × 512	0:18	200 × 200

TR, (Time of Repititions); TE, (Time of Echo); FA, (Flip Angle); ETL, (Echo-train length); FOV, (Field of View); T1WI, T1-weighted image; T2WI, T2-weighted image; 2D-FASE, two-dimensional fast asymmetric spin-echo sequences.