

Magnetic Resonance Sialography and Salivary Gland Scintigraphy of Parotid Glands in Sjögren's Syndrome

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Objective: To assess the correlation between conventional magnetic resonance (MR) imaging and MR sialography of parotid glands with salivary gland scintigraphy in patients with Sjögren's syndrome.

Methods: A retrospective study was conducted on eight patients with Sjögren's syndrome who underwent MR imaging and salivary gland scintigraphy. Conventional MR imaging techniques, such as T1-weighted images (T1WI), T2-weighted images (T2WI), and short TI inversion recovery images (STIR) were used for changes of fat signal in the parotid gland, while the MR sialography were used for ducts dilation of the parotid gland. Regarding scintigraphy, time-activity curves of each parotid gland were analysed. The salivary gland excretion fraction was defined as A (before stimulation test (counts/20 s)) and B (after stimulation test (counts/20 s)).

Results: Regarding characteristic appearances of fat signal, the A/B of parotid gland with homogeneous intensity distribution (3.51 ± 0.75) was higher than that with heterogeneous intensity distribution (1.56 ± 0.66 , $P = 0.001$). Regarding MR sialographic stages, the A/B of parotid gland with stage 0 (3.51 ± 0.75) was higher than that with stage 1 (2.03 ± 0.86 , $P = 0.009$) and with stage 2 (1.26 ± 0.25 , $P = 0.000$).

Conclusion: The results suggest that MR sialography of the parotid glands is a useful non-invasive tool for evaluating the decrease of salivary gland excretion in patients with Sjögren's syndrome.

Key words: magnetic resonance imaging, parotid gland, sialography, Sjögren's syndrome
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Sjögren's syndrome is a chronic, progressive, autoimmune disease, of unknown aetiology, characterised by focal lymphocytic infiltration of exocrine glands with a significant functional impairment, leading to sicca symptoms, such as the salivary and lachrymal glands, resulting in dry mouth and dry eyes^{1,2}. The diagnosis of Sjögren's syndrome involves clinical symptoms, serum tests for antibodies, radiological examinations and biopsy of the minor salivary gland³. Commonly used imaging tests that will facilitate the diagnosis include radiograph

sialography, salivary scintigraphy^{1,4,5} and various magnetic resonance (MR) imaging techniques^{2,6-11}.

MR imaging is non-invasive, radiation-free, and sensitive to the morphological and signal changes of the parotid glands, and MR sialography is widely used to evaluate the parotid ductal system without using any exogenous contrast agent¹¹. Salivary gland scintigraphy is a safe and sensitive method for assessing functions of salivary glands. Furthermore, not only the location and morphology of salivary glands can be obtained, but also quantitative parameters can be calculated¹. However, to the best of our knowledge, the correlation between conventional MR imaging and MR sialography of parotid glands with salivary gland scintigraphy in patients with Sjögren's syndrome have not been reported in the literature. This study aimed to assess the correlation between conventional MR imaging and MR sialography of parotid glands with salivary gland scintigraphy in patients with Sjögren's syndrome.

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**Table 1** A case of Sjögren's syndrome with MR imaging and salivary gland scintigraphy.

Case	Age (years)	Gender	MRI		A/B with salivary gland scintigraphy	
			Fat signal	Sialography	Parotid (R)	Parotid (L)
1	17	Female	Heterogeneous	Stage 2	1.08	1.41
2	57	Female	Homogeneous	Stage 0	3.04	4.00
3	61	Female	Heterogeneous	Stage 2	1.30	1.66
4	62	Female	Heterogeneous	Stage 1	2.50	2.99
5	65	Female	Heterogeneous	Stage 2	1.07	1.01
6	67	Female	Homogeneous	Stage 0	2.76	2.73
7	68	Female	Heterogeneous	Stage 1	1.27	1.34
8	69	Female	Homogeneous	Stage 0	4.41	4.11

MR, magnetic resonance; A, before stimulation test (counts/20 s); B, after stimulation test (counts/20 s); T1WI, T1-weighted image; T2WI, T2-weighted image; STIR, short TI inversion recovery; (R), right; (L), left.

Materials and methods

Patient population

The ethics committee of our institution approved this retrospective study. After providing written informed consent, eight patients (eight females; age range 17 to 69 years, mean age 58.3 years) with Sjögren's syndrome underwent MR imaging and salivary gland scintigraphy at our university hospital from January 2014 to April 2017. In all cases the histopathological diagnoses of Sjögren's syndrome were obtained by labial salivary gland biopsy.

Image acquisition

The MR images (1.5 Tesla MR unit; EXCELART Vantage MRT-2003; Toshiba Medical Systems, Otawara, Japan) with a head coil included unenhanced axial T1-weighted imaging (T1WI) [repetition time (TR) 660 ms, echo time (TE) 12 ms, T2-weighted imaging (T2WI, TR 4000 ms, TE 120 ms), short TI inversion recovery images (STIR, TR 2500 ms, TE 15 ms, TI 190 ms). For MR sialography, sialographic source images were then obtained with a 3-D fast spin-echo sequence (TR 5500 ms, TE 500 ms), and all images generated were analysed on the basis of maximum intensity projection (MIP) reconstruction.

Regarding salivary gland scintigraphy, after intravenous injection of approximately 370 MBq of ^{99m}Tc-

perchnetate, salivary gland scintigraphy was performed for 60 min with a gamma camera (SNC-5100R and Scintipack 24000; Shimadzu, Kyoto, Japan) with a 128 × 128 matrix, and dynamic images were recorded on the computer at 20 s/frame. Forty-five min after the dynamic images started, 10% citrate acid (0.5 mL) was administered orally to stimulate salivary gland excretion. The stored data were displayed on a screen for analysis.

Image analysis

Two oral and maxillofacial radiologists with more than 20 years of experience independently reviewed all images, and any discrepancies were resolved by consensus. Based on the characteristic appearances of fat signal on T1WI, T2WI, and STIR images, the MR images of the parotid glands were assessed with homogeneous and heterogeneous intensity distribution. The MR sialographic stages of Sjögren's syndrome were determined according to the criteria proposed by Tonami et al⁷ – stage 0: normal; stage 1: punctate appearance; stage 2: globular appearance; stage 3: cavity appearance; stage 4: destructive appearance. Regarding salivary gland scintigraphy, regions of interest (ROIs) of each parotid gland were drawn manually. Data were digitally stored and plotted on separate time-activity curves for each salivary gland after manual selection of the glands. The salivary gland excretion fraction was defined as A (before stimulation test (counts/20 s)) / B (after stimulation test (counts/20 s)).

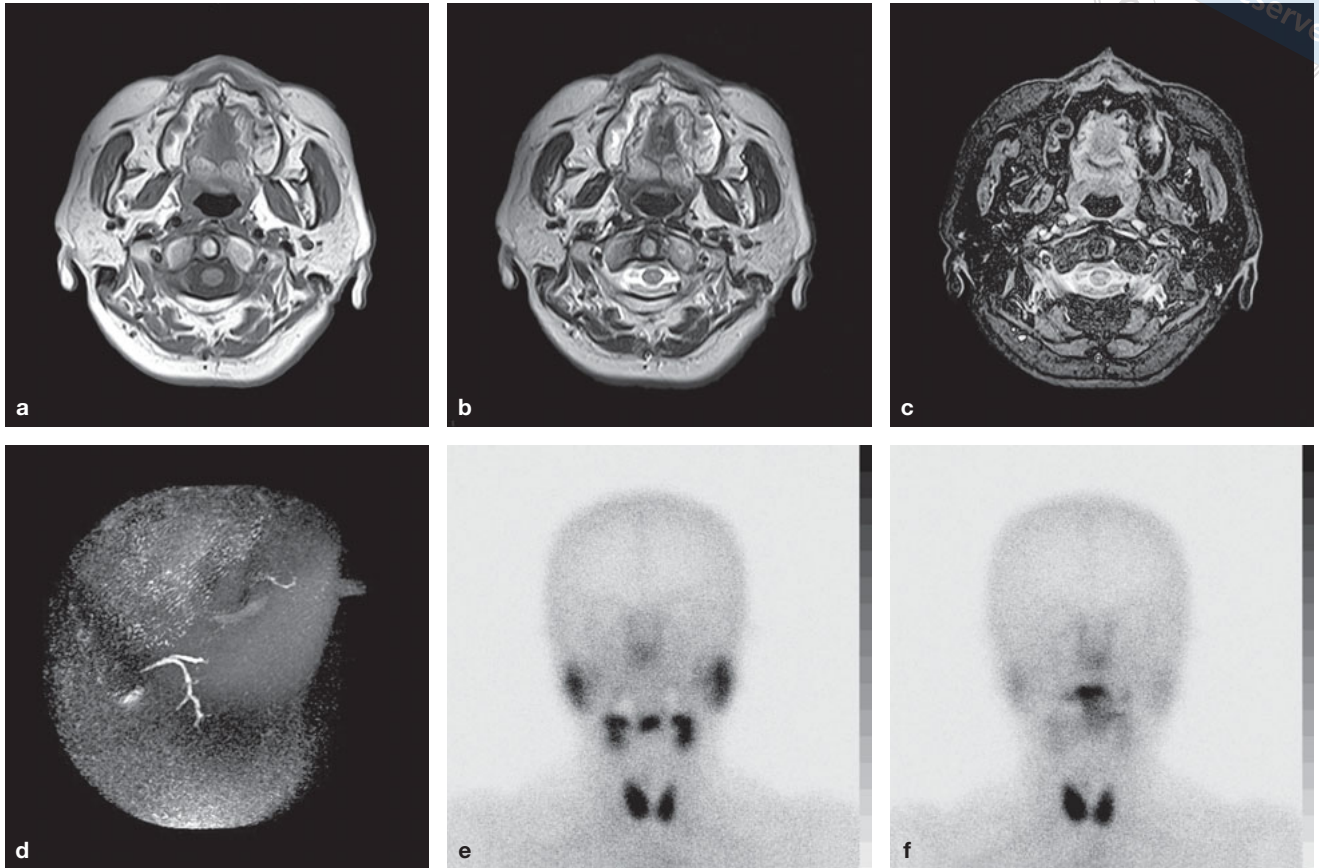


Fig 1 Sjögren's syndrome in a 57-year-old female. **(a)** T1-weighted image (T1WI); **(b)** T2-weighted image (T2WI) showing homogeneous hyperintensity of the bilateral parotid glands. Short T1 inversion recovery (STIR) images **(c)** show homogeneous hypointensity of the bilateral parotid glands. MR sialography **(d)** shows normal appearance (stage 0). Salivary gland scintigraphy before stimulation test shows increased uptake in the bilateral parotid glands **(e)**. Salivary gland scintigraphy after stimulation test shows decreased uptake in the bilateral parotid glands **(f)**.

Statistical analysis

The statistical analysis with respect to the characteristic appearances of fat signal on MR imaging and A/B with salivary gland scintigraphy was performed with the Mann-Whitney U test for non-parametric data. The statistical analysis with respect to the MR sialographic stages and A/B with salivary gland scintigraphy was performed with one-way repeated measures analysis of variance. If there was a significant difference, then the Tukey's HSD test for multiple comparisons was performed to determine which pair showed a significant difference. These analyses were performed with the statistical package IBM SPSS Statistics version 24 (IBM Japan, Tokyo, Japan). A *P*-value less than 0.05 was considered statistically significant.

Results

Table 1 shows cases of Sjögren's syndrome with MR imaging and salivary gland scintigraphy. Of eight Sjögren's syndrome patients, three had homogeneous intensity distribution, and all patients registered stage 0 on the sialographic images (Fig 1). Five patients had heterogeneous MR signals with different degrees of fat signals, and the patients were 2 (stage 1), and 3 (stage 2) on the sialographic images (Fig 2).

MR imaging and salivary gland excretion fraction with salivary gland scintigraphy in Sjögren's syndrome are shown in Table 2. Regarding characteristic appearances of the fat signal, the A/B of parotid gland with homogeneous intensity distribution (3.51 ± 0.75) was higher than that with heterogeneous intensity distribution (1.56 ± 0.66 , $P = 0.001$). Regarding MR sialographic stages, the A/B of parotid gland with stage 0 (3.51 ± 0.75) was higher than that with stage 1 (2.03 ± 0.86 , $P = 0.009$) and with stage 2 (1.26 ± 0.25 , $P = 0.000$).

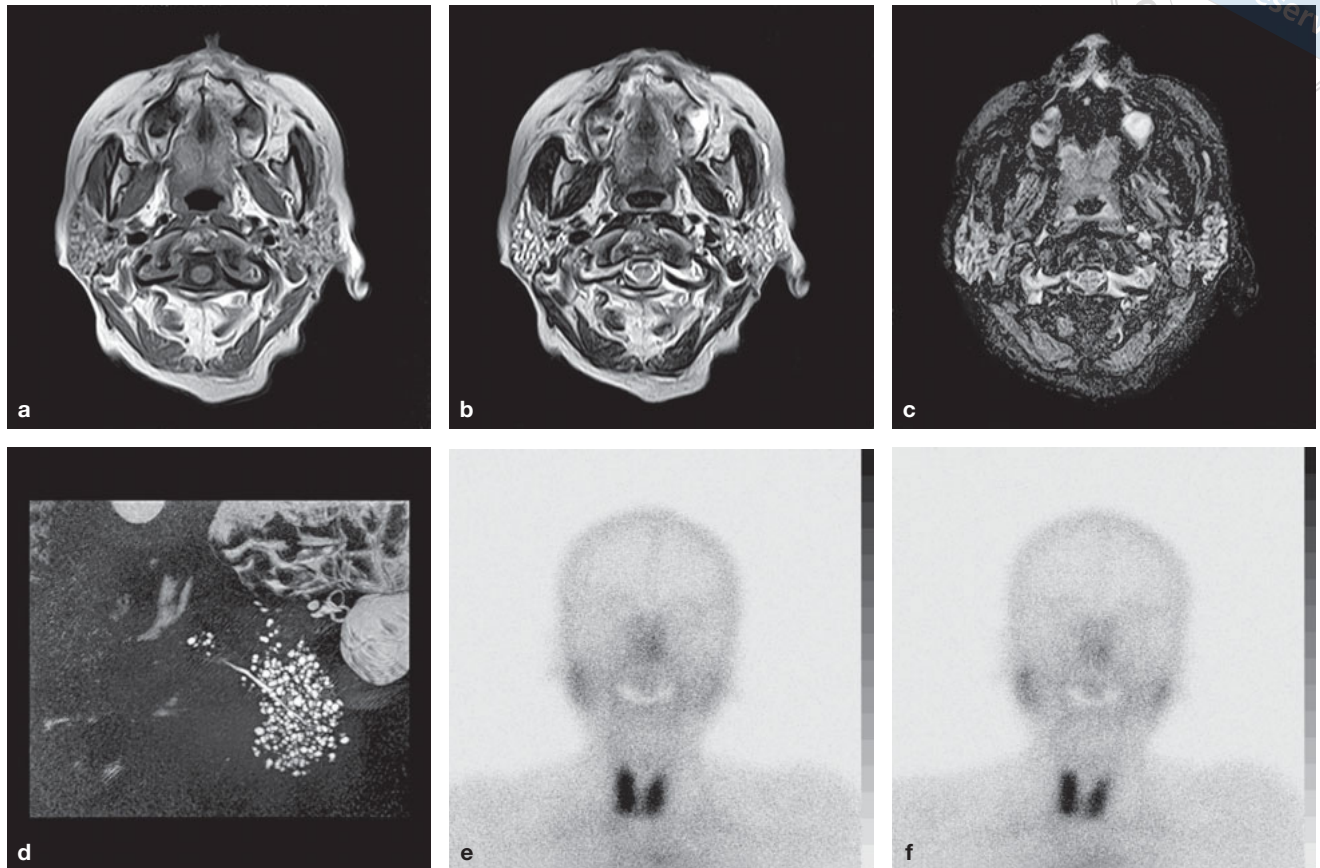


Fig 2 Sjögren's syndrome in a 65-year-old female. T1WI (a), T2WI (b) and STIR images (c) show heterogeneous hyperintensity of the bilateral parotid glands. MR sialography (d) shows globular appearance (stage 2). Salivary gland scintigraphy before (e) and after (f) stimulation test shows decreased uptake in the bilateral parotid glands.

Table 2 MR imaging and salivary gland excretion fraction with salivary gland scintigraphy in Sjögren syndrome.

MR imaging	Number of parotid glands	A/B with salivary gland scintigraphy		
		Mean ± SD	Range	P-value
Characteristic appearances of fat signal	16			0.001
Homogeneous intensity distribution	6	3.51 ± 0.75	2.73–4.41	
Heterogeneous intensity distribution	10	1.56 ± 0.66	1.01–2.99	
Sialographic stages	16			
Stage 0	6	3.51 ± 0.75	2.73–4.41	
Stage 1	4	2.03 ± 0.86	1.27–2.99	0.009
Stage 2	6	1.26 ± 0.25	1.01–1.66	0.000

MR, magnetic resonance; A, before stimulation test (counts/20 s); B, after stimulation test (counts/20 s); SD, standard deviation.

Discussion

In Sjögren's syndrome, there is massive lipid infiltration and degeneration in parotid glands. In the early stage of fat infiltration, sparse punctate or streak-like high signal spots are commonly observed on T1WI, while the signal change on T2WI and STIR is not obvious. With advancement in the severity of the disease, the fat deposition progresses, as evidenced by diffusive high-signals with stripe-, lattice-, or patchy-appearance on T1WI and T2WI.

However, regardless of grading, the distribution of fat signal is diffusive and irregular, which is characteristic for parotid glands in Sjögren's syndrome patients⁷. Ren et al² showed the usefulness of combining MR imaging and MR sialography when diagnosing Sjögren's syndrome and the disagreement between fat signal staging and parotid duct dilation staging. Kojima et al⁹ concluded the presence of multiple high-signal-intensity spots on an MR sialogram in the parotid gland should be considered the best diagnostic indicator for Sjögren's syndrome. In this study, we showed that three out of eight Sjögren's syndrome patients had homogeneous intensity distribution, and that all patients were stage 0 on the sialographic images. Furthermore, five patients had heterogeneous MR signals with different degree of fat signals, and the patients were stage 1 and three patients were stage 2 on the sialographic images. We consider that MR imaging is a well-recognised, effective tool for Sjögren's syndrome diagnosis.

Vinagre et al⁴ showed salivary gland scintigraphy is a non-invasive, reliable and broadly accepted method for the evaluation of salivary glands function in xerostomic patients, moreover, salivary gland scintigraphy is accepted by the international classification criteria for Sjögren's syndrome as an objective assessment method of salivary gland involvement. Angusti et al⁵ indicated that semi-quantitative analysis of salivary gland scintigraphy is an accurate and reproducible tool for the diagnosis of Sjögren's syndrome. In this study, we showed MR imaging and salivary gland excretion fraction with salivary gland scintigraphy in Sjögren's syndrome. Regarding characteristic appearances of fat signal, the A/B of parotid gland with homogeneous intensity distribution (3.51 ± 0.75) was higher than that with heterogeneous intensity distribution (1.56 ± 0.66 , $P = 0.001$). Regarding MR sialographic stages, the A/B of parotid gland with stage 0 (3.51 ± 0.75) was higher than that with stage 1 (2.03 ± 0.86 , $P = 0.009$) and with stage 2 (1.26 ± 0.25 , $P = 0.000$). Therefore, we consider that MR sialography of the parotid glands is a useful,

non-invasive tool for evaluating decrease of salivary gland excretion in patients with Sjögren's syndrome.

There were several limitations to this study. The sample was relatively small. Therefore, further research is necessary to validate these results. Furthermore, in recent years, Chu et al explored the correlation between intravoxel incoherent motion MR parameters and MR nodular grade of parotid glands in patients with Sjögren's syndrome¹⁰ and the role of diffusion kurtosis imaging of parotid glands in diagnosing Sjögren's syndrome¹¹. We consider that those MR studies had technical innovations.

In conclusion, we assessed the correlation between conventional MR imaging and MR sialography of parotid glands with salivary gland scintigraphy in patients with Sjögren's syndrome. The results suggest that MR sialography of the parotid glands is a useful non-invasive tool for evaluating decrease of salivary gland excretion in patients with Sjögren's syndrome.

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Conflicts of interest

The authors reported no conflicts of interest related to this study.

Author contribution

Dr Ichiro OGURA designed the work, acquired the case data, and prepared the manuscript; Dr Yoshihiko SASAKI analysed the radiological data; Dr Takaaki ODA revised the manuscript; Dr Mikiko SUE interpreted the radiological data; Dr Kazuhide HAYAMA approved the final revised manuscript.

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