Study of relationship between maxillofacial lesions and cervical lymphadenopathy using MR imaging

(MRI を用いた顎顔面疾患と頸部リンパ節腫脹の関連性)

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本論文は、

1) Parotid lymphadenopathy is associated with joint effusion in nonneoplastic temporomandibular disorders

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2) Lymphadenopathy of the Maxillofacial Area Caused by Periodontitis

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1, Abstract

Purposes

Joint effusion, a pathological accumulation of synovial fluid caused by inflammation, is easily identified on magnetic resonance imaging (MRI), and there have been many studies of its relationship to joint pain, disk displacement, and abnormal marrow signal. Periodontitis is an inflammatory disease of the supporting tissues of the teeth caused by specific microorganisms, resulting in progressive destruction of the periodontal ligament and alveolar bone with increased probing depth formation, recession, or both. Lymphadenopathy often occurs in the setting of inflammation with or without infection. There has been little attention devoted to the relationship between cervical lymphadenopathy and these maxillofacial lesions.

The purposes of this study were 1) to elucidate any association of parotid lymphadenopathy with joint effusion in temporomandibular joint (TMJ) disorders, 2) to investigate the appearance of lymph nodes draining areas of periodontitis in the mandible using axial short T1 inversion recovery magnetic resonance imaging.

Materials and methods

The present study designed and implemented a retrospective cohort study, which was approved by our university ethics committee (EC15-12-009-1).

1) The present study analyzed the magnetic resonance imaging (MRI) studies of 402 TMJs in 201 patients (47 men, 154 women; 8–82 years of age, mean age 34.3 years). with suspected TMJ disorders performed between April 2006 and March 2007 (without any diseases that would affect the lymph nodes).The degree of joint effusion was graded on sagittal T2-weighted spin-echo (SE) images according to a commonly used system. On axial short TI inversion recovery (STIR) images, the number and short-axis diameter of parotid lymph nodes were recorded. 2) The number and short-axis diameter of submental lymph nodes, submandibular nodes, superior internal jugular nodes, and spinal accessory nodes were measured on magnetic resonance images in 216 subjects in 108 patients from April 2012 to March 2015 (27 men, 81 women; 21–81 years of age, mean age 54.5 years). Between-group differences in the number and diameter of the nodes were analyzed.

Results

1) A total of 402 TMJ disorders were analyzed from 201 patients over the study period. The number and size of parotid lymph nodes identified was significantly higher in the patients with TMJ effusion ($P < .01$) than in those without effusion. 2) The size and number of submental nodes, submandibular nodes, and superior internal jugular nodes were significantly different between the periodontitis group and the

non-periodontitis group ($P < .01$). The size and number of spinal accessory nodes were not significantly different between the two groups ($P > .05$).

Conclusion

This study found that 1) an association between parotid lymphadenopathy and joint effusion in TMJ disorders, 2) a definite pattern of lymphadenopathy is associated with periodontitis. These findings indicate that lymphadenopathy should be considered as an inflammation condition commonly associated with joint effusion in TMD and periodontitis.

Key Words:

Cervical lymphadenopathy, Joint effusion, Periodontitis, Parotid lymph nodes, Submental nodes, Submandibular nodes, Superior internal jugular nodes, Spinal accessory nodes, MRI

2, Introduction

Temporomandibular joint (TMJ) disorders are a major cause of non-dental pain in the orofacial region. They are considered to be a subclass of musculoskeletal disorders.[1] Abnormalities of disk position and configuration, posterior disk attachment, and mandibular marrow, as well as joint effusion, have been reported previously.[2] Joint effusion, a pathological accumulation of synovial fluid caused by inflammation, is easily identified on magnetic resonance imaging (MRI), and there have been many studies of its relationship to joint pain, disk displacement, and abnormal marrow signal.[3-7]

Periodontitis is an inflammatory disease of the supporting tissues of the teeth caused by specific microorganisms, resulting in progressive destruction of the periodontal ligament and alveolar bone with increased probing depth formation, recession, or both.[8] At least two of these microorganisms, *Porphyromonas gingivalis* and *Actinobacillus actinomycetemcomitans*, are virulent organisms that invade the periodontal tissue. The clinical feature that distinguishes periodontitis from gingivitis is the presence of clinically detectable attachment loss.[8] The loss often is accompanied by periodontal pocket formation and changes in the density and height of subjacent alveolar bone. In recent years, questions have arisen about periodontal disease's influence upon smoking and systemic diseases.[9-14] Many studies have reported periodontitis as a risk factor for chronic medical disorders, including cardiovascular disease, cerebrovascular accidents, and low-birth-weight infants. Diabetes mellitus, HIV infection, and cigarette smoking have been known as risk factors for periodontitis. [9-14]

The approximately 800 lymph nodes in the body, 300 are situated in the head and neck.[15. 16] The cervical lymph nodes are often divided into five groups. The parotid lymph nodes are situated both superficial to the gland and within the gland itself. They can number from 7 to 19.[15] These lymph nodes drain an extensive territory, including the forehead and temporal regions, portions of the middle and lateral parts of the face, the auricles, external auditory canals, the Eustachian tubes, portions of the posterior part of the cheeks, buccal mucous membranes, gums, and the parotid gland itself.[15]

Enlargement of lymph nodes, or lymphadenopathy, can be reactive, in the case of inflammation, where various cells involved in the inflammatory process (e.g. lymphocytes, histiocytes, and macrophages) collect in the nodes, enlarging them.[17] Nodes enlarged by metastases fill with multiplying neoplastic cells that destroy the normal nodal architecture.[15]

The purposes of this study were 1) to investigate the relationship between parotid lymphadenopathy and TMJ effusions using MRI, 2) to characterize lymphadenopathy of the maxillofacial area associated with periodontitis.

3, Materials and Methods

The present study designed and implemented a retrospective cohort study, which was approved by our university ethics committee (EC15-12-009-1).

STUDY DESIGN/SAMPLE

3-1) Parotid lymphadenopathy is associated with joint effusion in nonneoplastic temporomandibular disorders

The study population was composed of all patients presenting for evaluation and management of symptoms including TMJ pain, difficulty in opening the mouth completely, locking of the TMJ in open- or closed-mouth position, and clicking/popping/grating sounds accompanying chewing or mouth opening, who had undergone MRI between April 2006 and March 2007. Exclusion criteria were anemias, inflammatory diseases, leukemias, lymphomas, and metastatic tumors. We analyzed a total of 402 TMJ disorders in 201 patients (with fluid group 10 - 82 years (n =131), without fluid group 8 - 82 years (n =271)). The main predictors of interest were lymph node size and number.

3-2) Lymphadenopathy of the maxillofacial area caused by periodontitis

This study included 216 regions in 108 patients evaluated for periodontitis by alveolar bone loss, whole mouth probing depth, and gingival bleeding (with periodontitis group

21 - 81years (n =97), without periodontitis group 29 - 79 years (n =119)) who underwent magnetic resonance imaging (MRI) of the brain at the Nihon University School of Dentistry Hospital, Matsudo, Chiba, Japan, from April 2012 to March 2015. Exclusion criteria were a history of radiotherapy, and disease (e.g., hematological disorders and diabetes mellitus, tumor or cyst of the mandible, inflammatory diseases, lymphomas, metastatic tumors) affecting the mandibular bone marrow and lymph nodes.

DATA COLLECTION

3-1) Parotid lymphadenopathy is associated with joint effusion in nonneoplastic temporomandibular disorders

The subjects had all undergone imaging with a 1.5 T MR scanner (Intera Achieva® 1.5 T: Philips Medical Systems, Best, the Netherlands) with a TMJ surface coil and a neck coil.

Imaging sequences included oblique sagittal T2-weighted spin echo (SE) imaging of the TMJ and axial short TI inversion recovery (STIR) imaging from the neck to the skull base. T2-weighted images (T2WI) were acquired using the following parameters: TR/TE = 3500/120 and 120 msec, 3.0 mm section thickness, 192 × 256 matrix, 120 × 120 mm field of view, and one acquisition using the TMJ surface coil. Axial STIR images were acquired using the following parameters: TR/TE/TI = 2600/60/100 msec, 6 mm section thickness, 256 ×256 matrix, 230 × 230 mm field of view for one acquisition using the neck coil. The degree of joint effusion was evaluated on sagittal T2WI according to the TMJ fluid classification (grading system) described by Larheim et al.[4]: “no fluid,” “minimal fluid,” “moderate fluid,” “marked fluid,” and “extensive fluid.”

On axial STIR images, the number and short-axis diameter of parotid lymph nodes were independently measured and recorded on a workstation by two oral radiology specialists. When disagreements occurred, the radiologists reached the final size by consensus. Cases were subdivided into those with and those without a TMJ effusion.

3-2) Lymphadenopathy of the maxillofacial area caused by periodontitis

MR imaging was performed with a 1.5-T superconductive MR unit (Intera Achieva® 1.5 T Nova; Philips Medical Systems, Best, Netherlands) and head coil. Short tau inversion recovery (STIR) images were obtained using a spin echo sequence with the following parameters: repetition time, echo time, and inversion time were set at 2500, 60, and 180 milliseconds, respectively. Other study conditions were set as follows: section thickness, 6 mm; matrix, 320 × 256; field of view, 230 × 195.5 mm; and 1 acquisition.

Analyzing the STIR axial images, the number and short-axis diameter of lymph nodes in the head and neck region were classified into four categories, with the location of lymph nodes following the level system of Som et al. [18. 19]

Images including the mandible were divided into two regions: Left side of the mandibular bone and right side of the mandibular bone. (Fig 1) The present study excluded sites with missing teeth from evaluation. A total of 216 sites were evaluated. All MR images were evaluated by two radiologists. When disagreements occurred, the radiologists reached the final size by consensus. The baseline structures adopted to evaluate STIR MR signal intensity were cerebrospinal fluid (high signal intensity), muscle (intermediate signal intensity), and fat (low signal intensity). The present study classified signal intensity into five categories that included intermediate-to-high signal intensity and low-to-intermediate signal intensity.

Normal bone marrow was considered to have low signal intensity. When bone marrow signal intensity was higher than that of fat, it was considered edematous. In consideration of Muramatsu et al.'s [20] report, we defined bone marrow edema as periodontitis in this study.

DATA ANALYSIS

3-1) Parotid lymphadenopathy is associated with joint effusion in nonneoplastic temporomandibular disorders

Each of the two groups were then compared using the Mann-Whitney U test. Spearman's correlation coefficients were calculated using fluid classification as the criterion variable and the number and short-axis diameter of lymph nodes as explanatory variables. These analyses were performed with the statistical package (SPSS version 21.0®, IBM Japan Inc., Tokyo, Japan). $P < .05$ was considered to indicate significance.

3-2) Lymphadenopathy of the maxillofacial area caused by periodontitis

Each of the two groups were then compared using the Mann-Whitney U-test. Spearman's correlation coefficients were calculated using bone marrow signal intensity as the criterion variable and the number and short-axis diameter of lymph nodes as explanatory variables. These analyses were performed with a statistical package (SPSS version 21.0®, IBM Japan Inc., Tokyo, Japan). $P < .05$ was considered to indicate significance.

4, Results

4-1) Parotid lymphadenopathy is associated with joint effusion in nonneoplastic temporomandibular disorders

Table 1 shows the presence of joint effusions and lymph nodes. The number and size of parotid lymph nodes were significantly different between the with joint effusion group and the without joint effusion group. The mean values of the number of nodes were 2.40±1.13 and 0.89±0.96 in the with joint effusion group and without joint effusion group, respectively ($P < .01$). The mean values of the size of nodes were 3.62±0.95 mm and 2.80±0.83 mm in the with joint effusion group and the without joint effusion group, respectively ($P < .01$). The "with fluid" group showed significantly more parotid lymph nodes (Fig 2, 3). Table 2 shows the correlations between TMJ fluid classification and the number and short-axis diameter of parotid lymph nodes. There were significant correlations between TMJ fluid classification and the number and short-axis diameter of parotid nodes ($P < .01$). As the TMJ fluid classification increased, the occurrence of parotid lymph nodes on MR images also increased.

4-2) Lymphadenopathy of the maxillofacial area caused by periodontitis

Table 3 shows the lymph node size and number in the presence of periodontitis. The number and size of submandibular nodes and superior internal jugular lymph nodes were significantly different between the periodontitis group and non-periodontitis group. The mean values of the size of submental nodes were 3.43 ± 0.89 mm and 2.95 ± 0.95 mm, corresponding to the periodontitis group and non-periodontitis group, respectively (*P* < .05). The mean values of the number of submandibular nodes were 2.40 ± 0.76 and 1.85 ± 0.62, corresponding to the periodontitis group and non-periodontitis group, respectively (*P* < .01). Mean values of the size of submandibular nodes were 5.21 ± 1.45 mm and 4.20 ± 1.00 mm, corresponding to the periodontitis groups and non-periodontitis group, respectively (*P* < .01). The mean values of the number of superior internal jugular lymph nodes were 2.10 ± 0.80 and 1.65 ± 0.56, corresponding to the periodontitis group, and non-periodontitis group, respectively (*P* < .01). The mean values of the size of the superior internal jugular lymph nodes were 5.70 ± 1.51 mm and 4.93 ± 1.29 mm, corresponding to the periodontitis group, and non-periodontitis group, respectively (*P* < .01). The periodontitis group showed significantly more lymph nodes, other than submental nodes and spinal accessory nodes, compared with the non-periodontitis group. (Fig 4, 5). Table 4 shows the correlation between bone marrow signal intensity (periodontitis classification) and the number and short-axis diameter of each lymph node. There was significant correlation between bone marrow signal intensity and the number and short-axis diameter of each node other than spinal accessory nodes (P < .01). Increased bone marrow signal intensity was associated with an increase in the number of lymph nodes.

5, Discussion

The purpose of this study was to investigate parotid lymphadenopathy and its association with maxillofacial lesions such as joint effusion and periodontitis. The present study hypothesized that lymphadenopathy would be associated with maxillofacial lesions. The number and size of lymph nodes were associated positively with the presence and degree of maxillofacial lesions.

5-1) Parotid lymphadenopathy is associated with joint effusion in nonneoplastic temporomandibular disorders

The number and size of parotid lymph nodes were associated positively with the presence and degree of effusion. MRI is the modality of choice for the investigation of TMJ disorders. Joint effusion has been cited as being related to pain.[2, 3] Joint effusion is defined as the pathological accumulation of synovial fluid appearing in the articular cavity and there are reports concerning fluid accumulation in the knee and hip joints.[2-7, 21, 22] MRI studies have investigated the articular disk, marrow signal, and deformity of the mandibular condyle.[7] The parotid nodes drain primarily into the internal jugular chain (level IIA) and also into the upper spinal accessory chain (level IIB). Overall, the most common tissue drained by these nodes is the skin, and thus the most common tumors to metastasize to them are melanomas and squamous cell carcinomas.[15, 16]

Dolwick et al. first reported that the parotid lymph nodes drain the TMJ region.[23]

Som et al's [19] investigation of cervical lymph node size in the evaluation of nodal metastases from malignant tumors did not include the parotid lymph nodes. In this study, the mean size for parotid lymph nodes without joint effusion were a short-axis diameter of 2.80 ± 0.83 mm in all age groups.

The results of this study suggested that age and sex were not significant predictors of having TMJ effusion. TMJ disorders are normally observed to be of a higher frequency in youth; however, this study found that age was not a significant predictor of TMJ effusion.[24]

MRI has become an important noninvasive imaging technique for temporomandibular disorders. Therefore, this study investigated relationship between parotid lymphadenopathy and joint effusion. To investigate the relationship between parotid lymph nodes and TMJ effusion, STIR axial imaging focused on the parotid lymph nodes. STIR sequences are sensitive to changes in both T1 and T2; these relaxation time signals are additive and so increase the contrast between different soft tissues.

5-2) Lymphadenopathy of the maxillofacial area caused by periodontitis

Significant differences were observed in the number and short axis diameter of lymph nodes between the periodontitis group and the non-periodontitis control group in this study. Significant correlations between bone marrow signal intensity (periodontitis classification) and the number and short-axis diameter of submandibular and superior internal jugular nodes were noted.

Of the approximately 800 lymph nodes in the body, 300 lymph nodes are situated in the head and neck. Thus, approximately 40% of the lymph nodes in the body are located in approximately 20% of the body's volume.[15] This is, in part, understandable, as they drain the nontraumatic portal of entry of most pathogens. The cervical lymph nodes are often divided into five groups, all of which are contiguous with each other. Lymphatic drainage in the head and neck region from the mandible, lips, cheeks, and oral cavity occurs via the submental lymph nodes, submandibular nodes, and then the deep cervical lymph nodes.[15] The deep cervical lymph nodes also receive drainage from the parotid gland and the retropharyngeal area. The spinal accessory nodes receive lymphatic drainage from the occipital, mastoid, parietal scalp, lateral neck and shoulder areas. Submandibular nodes and superior internal jugular nodes of comparatively larger size than those in other regions are regarded as normal because they receive lymphatic drainage from the oral region, and the oral cavity is a region frequently affected by various diseases such as tooth decay and periodontal diseases, which are regarded as bacterial infections caused by the flora resident in the oral cavity.[15]

On the other hand, periodontitis is a highly prevalent chronic inflammatory disease caused by primarily by anaerobic gram-negative oral infection that leads to gingival inflammation, destruction of periodontal tissues, loss of alveolar bone, and loss of teeth. This disease is also associated with an increased risk of heart attack, stroke, and other serious health problems. The clinical parameters of alveolar bone loss, gingival bleeding, and probing depth have been used routinely to determine periodontal disease status. The most common cause of bone destruction in periodontal disease is the extension of inflammation from the marginal gingiva into the supporting periodontal tissues. The inflammatory invasion of the bone surface and the resulting bone loss marks the transition from gingivitis to periodontitis.[8]

The mandible is a tubular structure of dense cortical bone filled with trabecular bone and bone marrow.[8] The bone marrow in the body of a normal adult is known to consist of red marrow and yellow marrow. Kaneda et al.[25] reported marrow conversion from the immature red to the mature yellow stage was first seen in the anterior region of the mandibular body on MR images. With aging, marrow conversion was observed in the premolar/molar region, angle, ramus, and condyle in that order. Muramatsu et al.[20] reported bone marrow abnormalities in a high percentage of MR images of mandibles of patients with periodontitis. Bone marrow edema is a hallmark of periodontitis in the mandible. Evaluation of bone marrow is critical for the diagnosis, treatment, and prognosis of patients with lymphohematopoietic disorders including anemias, inflammatory diseases, leukemias, lymphomas, and metastatic tumors.

MRI has been used in lymph nodes to examine their size, signal intensity, and morphology. It has become an important noninvasive imaging technique for bone marrow disorders. Therefore, this study investigated relationship between lymphadenopathy and bone marrow edema (periodontitis). To investigate this relationship, this study used STIR axial imaging and focused on the lymph nodes. The present study found a direct correlation between the presence of periodontitis and abnormalities of the lymph nodes draining the oral cavity regions.

6, Conclusion

These results suggest that parotid lymphadenopathy is associated with joint effusion in TMJ disorder. And second, these results found that a definite pattern of lymphadenopathy is associated with periodontitis. These information could be useful for the differential diagnosis of abnormal lymph nodes.

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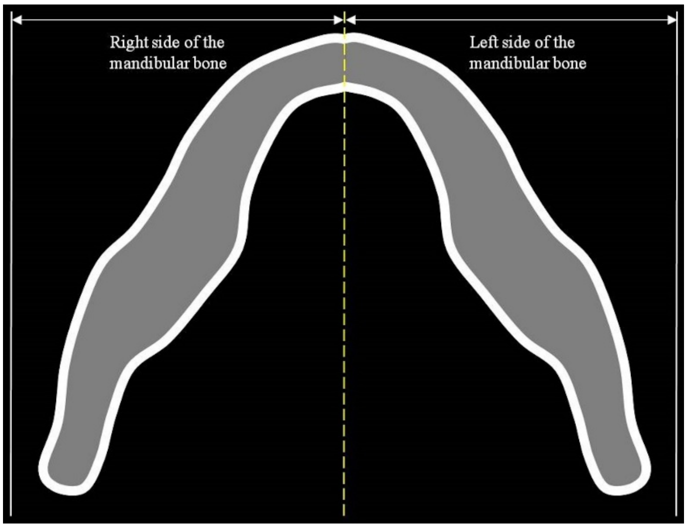

Fig 1.

The mandibular image was divided into two regions: Left side of the mandibular bone and right side of the mandibular bone.

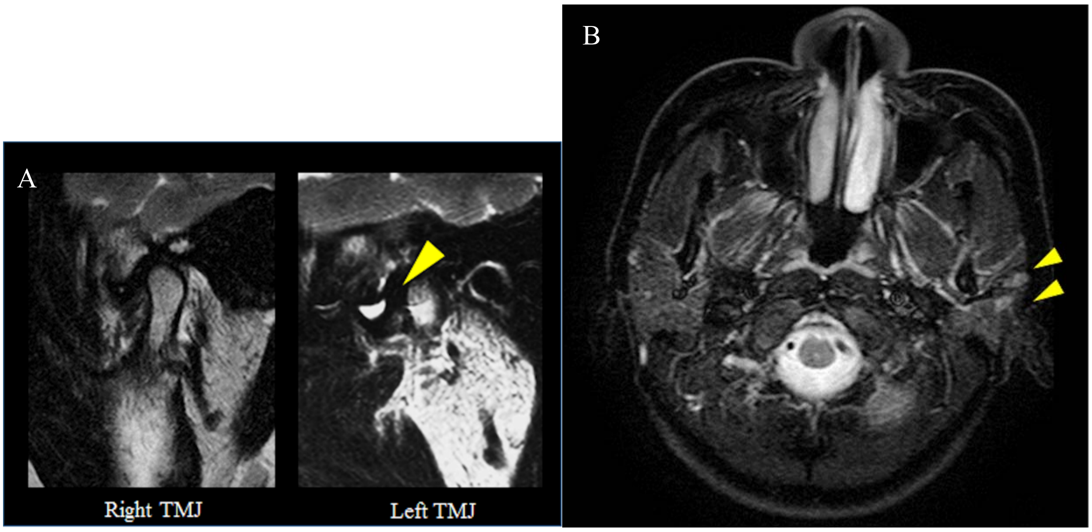

Fig 2.
An 18-year-old woman with temporomandibular disorder symptoms on the left side.
A, T2-weighted image shows extensive joint effusion (arrowhead).
B, Axial STIR MR image shows left parotid lymphadenopathy (arrowheads).

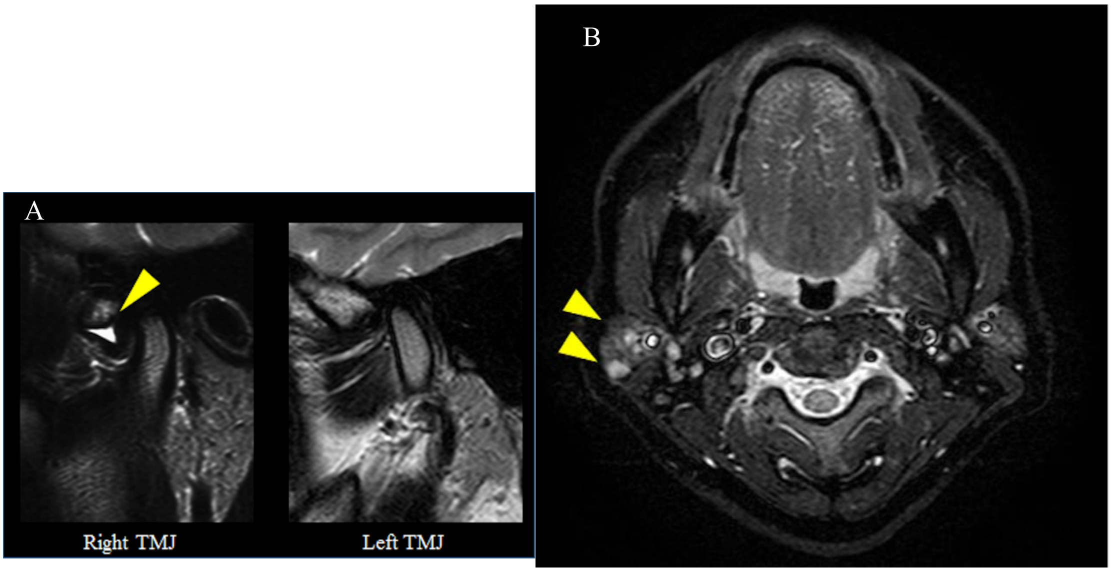

Fig 3.

A 33-year-old woman with temporomandibular disorder symptoms on the right side.

A, T2-weighted image shows extensive joint effusion (arrowhead).

B, Axial STIR MR image shows right parotid lymphadenopathy (arrowheads).

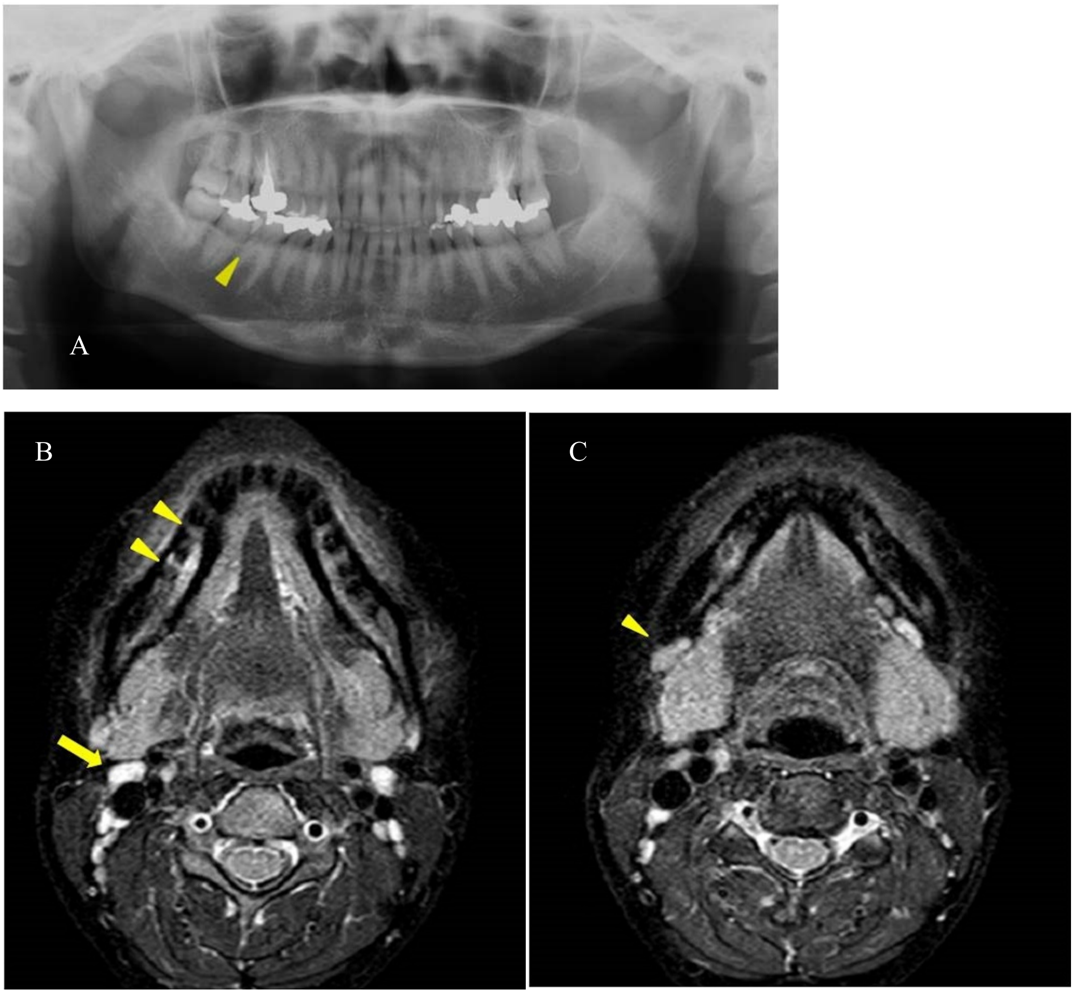

Fig 4.

A 39-year-old women with periodontitis.

A, Slight alveolar bone resorption is seen on panoramic radiograph of the mandible (arrowheads).

B, Axial STIR MR image shows bone marrow edema (arrowheads). Prominent superior internal jugular nodes are seen (arrow).

C, Axial STIR MR image shows prominent submandibular nodes (arrowhead).

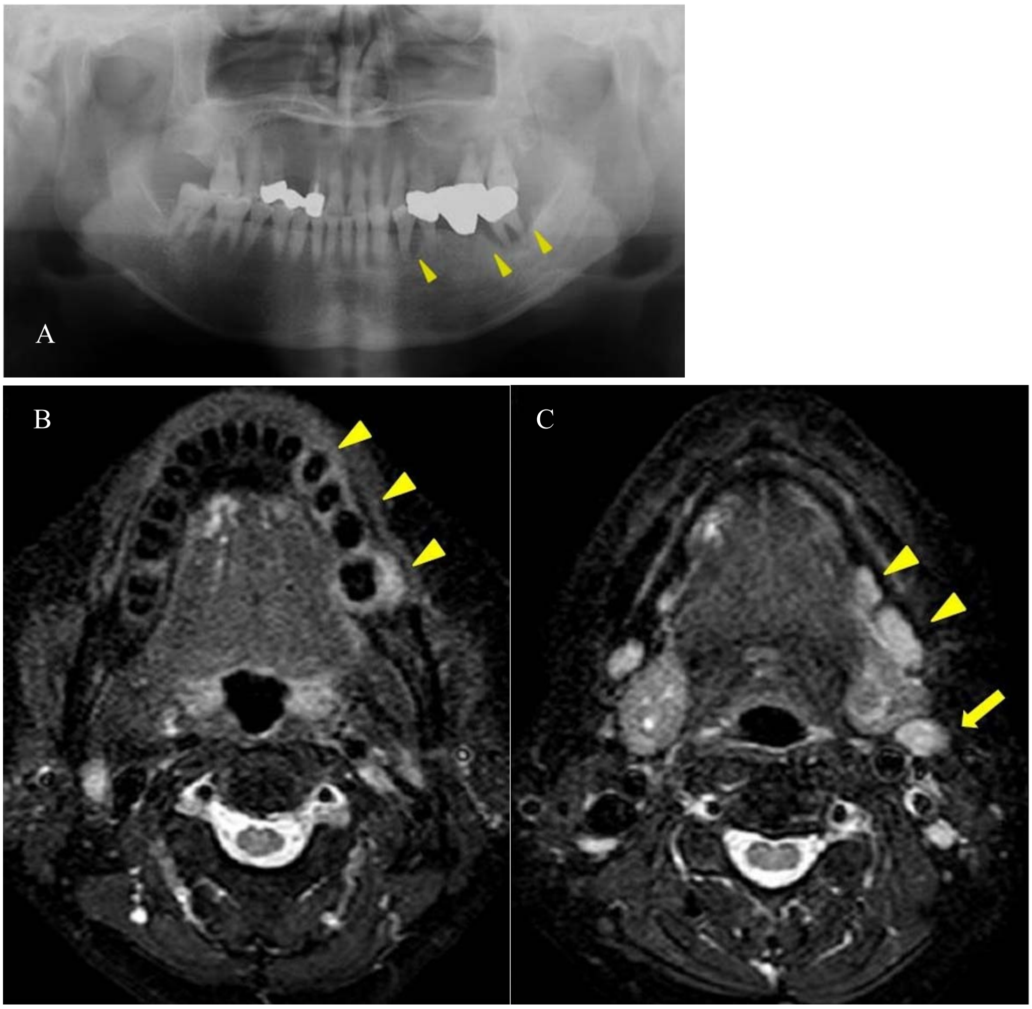

Fig 5.

A 75-year-old women with periodontitis.

A, Severe bone resorption is seen on panoramic radiograph of the mandible (arrowheads).

B, Axial STIR MR image shows bone marrow edema (arrowheads).

C, Axial STIR MR image shows prominent submandibular nodes (arrowhead). Prominent superior internal jugular nodes are seen (arrow).

Table1. Relationship between the presence of joint effusion and lymphadenopathy

	Average numbers of nodes (No. ± SD)		Average size of nodes (mm ± SD)	
	Without fluid	With fluid	Without fluid	With fluid
Parotid lymph nodes (Right)	0.82 (±0. 87)	2.32 (±1.11)	2.85 (±0.82)	3.67 (±1.03)
	**		**	
Parotid lymph nodes (Left)	0.94 (±1.03)	2.36 (±1.14)	2.70 (±0.84)	3.56 (±0.85)
	**		**	
Parotid lymph nodes	0.89 (±0.96)	2.34 (±1.13)	2.80 (±0.83)	3.62 (±0.95)
	**		**	

SD = standard deviation

* : $P < .05$ ** : $P < .01$

Table2. Relationship between the TMJ fluid classification and the lymphadenopathy.

		TMJ fluid classification					R
		No	Minimal	Moderate	Marked	Extensive	
Parotid lymph nodes(Right)	Average numbers (No. ± SD)	0.82 (±0.87)	2.16 (±1.08)	2.54 (±1.15)	2.47 (±1.15)	2.83 (±0.69)	0.543**
	Average size (mm ± SD)	2.85 (±0.82)	3.68 (±0.90)	3.47 (±1.01)	3.66 (±1.20)	4.80 (±1.38)	0.250**
Parotid lymph nodes(Left)	Average numbers (No. ± SD)	0.94 (±1.03)	2.28 (±1.14)	2.52 (±1.17)	2.36 (±0.72)	2.75 (±1.48)	0.524**
	Average size (mm ± SD)	2.76 (±0.84)	3.43 (±0.75)	3.70 (±1.04)	3.78 (±0.83)	4.13 (±0.74)	0.391**
Parotid lymph nodes	Average numbers (No. ± SD)	0.89 (±0.96)	2.21 (±1.11)	2.53 (±1.16)	2.41 (±0.97)	2.79 (±0.43)	0.326**
	Average size (mm ± SD)	2.80 (±0.83)	3.54 (±0.84)	3.57 (±1.03)	3.72 (±1.03)	4.44 (±1.14)	0.532**

SD = standard deviation   * : $P < .05$ ** : $P < .01$

R = correlation coefficient

Table3. Relationship between lymph node number and size and periodontitis.

	Average numbers of nodes (No. ± SD)		Average size of nodes (mm ± SD)	
	No periodontitis	Periodontitis	No periodontitis	Periodontitis
Submental nodes	0.46 (± 0.63)	0.63 (± 0.70)	2.95 (± 0.95)	3.43 (± 0.89)
			*	
Submandibular nodes	1.85 (± 0.62)	2.40 (± 0.76)	4.20 (± 1.00)	5.21 (± 1.45)
	**		**	
Superior internal jugular nodes	1.65 (± 0.56)	2.10 (± 0.80)	4.93 (± 1.29)	5.70 (± 1.51)
	**		**	
Spinal accessory nodes	2.50 (± 0.58)	2.56 (± 0.62)	2.47 (± 0.58)	2.60 (± 0.56)

SD = standard deviation

* : $P < .05$ ** : $P < .01$

Table 4. Relationship between the bone marrow signal intensity (Periodontitis classification) and lymph node number and size.

		Bone marrow signal intensity (Periodontitis classification)					
	Signal intensity	low	low-to-inter mediate	intermediate	intermediate-to -high	high	R
Submental nodes	mean number (No. ± SD)	0.46 (± 0.61)	0.59 (± 0.79)	0.65 (± 0.67)	0.75 (± 0.62)	0.60 (± 0.62)	0.122
	mean size (mm ± SD)	2.87 (± 0.97)	3.31 (± 0.87)	3.43 (± 0.91)	4.02 (± 0.54)	3.83 (± 0.54)	0.358**
Submandibular nodes	mean number (No. ± SD)	1.82 (± 0.60)	2.38 (± 0.68)	2.46 (± 0.82)	2.42 (± 0.79)	2.60 (± 1.14)	0.350**
	mean size (mm ± SD)	4.02 (± 0.92)	4.87 (± 1.15)	5.61 (± 1.34)	6.27 (± 1.59)	6.02 (± 2.01)	0.542**
Superior internal jugular nodes	mean number (No. ± SD)	1.65 (± 0.55)	1.96 (± 0.72)	2.15 (± 0.79)	2.50 (± 1.04)	2.20 (± 0.75)	0.329**
	mean size (mm ± SD)	4.79 (± 1.2)	5.58 (± 1.51)	5.91 (± 1.40)	6.0 (± 1.66)	7.04 (± 1.66)	0.370**
Spinal accessory nodes	mean number (No. ± SD)	2.49 (± 0.58)	2.57 (± 0.60)	2.52 (± 0.68)	2.50 (± 0.50)	2.80 (± 0.40)	0.163*
	mean size (mm ± SD)	2.47 (± 0.58)	2.51 (± 0.55)	2.61 (± 0.50)	2.98 (± 0.68)	2.60 (± 0.44)	0.046

SD = standard deviation

R = correlation coefficient

* : P <.05 ** : P < .01