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Clinical and radiologic findings of synovial chondromatosis affecting the temporomandibular joint

Juanhong Meng, DDS, PhD,[a,b] Chuanbin Guo, DDS, PhD,[b] Biao Yi, DDS, PhD,[b] Yanping Zhao, DDS, PhD,[a] Haiyan Luo, MD,[c] and Xuchen Ma, DDS, PhD,[a] Beijing, China
PEKING UNIVERSITY SCHOOL AND HOSPITAL OF STOMATOLOGY

Objectives. Our aim was to study the clinical and radiologic findings of synovial chondromatosis (SC) affecting the temporomandibular joint (TMJ) and provide references for diagnosis and treatment.
Study design. Twenty patients confirmed as SC histopathologically were included in the investigation. Nineteen cases were treated with arthrotomy and 1 case with arthroscopy. The clinical manifestations, radiographic findings, histopathologic features, surgical treatment, and differential diagnosis were combined to study this disease. The SC features of TMJ on magnetic resonance (MR) images were summarized on proton density–weighted (PD) and T2-weighted images.
Results. Synovial chondromatosis of TMJ occurred more often in women and on the right. Symptoms included preauricular pain, swelling, limitation of mouth opening, crepitations, and deviation on opening. The detection rate of calcified loose bodies was 30% on conventional radiographs and 53.3% on computerized tomography. Multiple small ring-like or tubular signals could be seen on PD and T2-weighted MR images. SC mainly affected the superior joint space; it could involve the inferior space when a perforated or deformed disc was present. SC could extend into intracranial fossa, infratemporal fossa, and lateral pytergoid muscle.
Conclusions. The characteristic ring-like signals could be found on MR images of the patients with SC of TMJ. This lesion should be differentially diagnosed with TMJ disorders and preauricular masses. Considering its recurrence and the different behavior of SC in different patients, various treatment strategies should be considered. **(Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2010;109:441-448)**

Synovial chondromatosis (SC) is a benign nodular cartilaginous proliferation in synovial joints. It usually affects large joints, such as the knee, hip, elbow, wrist, ankle, and shoulder, occurring twice as often in men as in women, with a mean age of onset in the fifth decade in large joints.[1,2] The temporomandibular joint (TMJ) has been thought to be rarely affected. The etiology of the disease in TMJ is unclear. Trauma, overuse, local infection, and embryologic disturbance may play a part in the development of these pathologies.[3,4] The commonest clinical symptoms and signs are unilateral pain, swelling, and crepitations in the joint. The clinical diagnosis of SC is made mainly based on imaging findings. Conventional radiography, computerized tomography (CT), magnetic resonance imaging (MRI), and arthroscopy are helpful in diagnosing of SC.[5-7] Imaging examinations are also helpful in both surgical treatment planning and follow-up.[8] The definitive diagnosis of synovial chondromatosis of the temporomandibular joint depends on histology.[9] Based on histopathologic study, Milgram[10] assigned 3 phases to SC: 1) active intrasynovial diseases with no loose bodies; 2) transitional lesions with both active intrasynovial proliferation and loose bodies; and 3) multiple free osteochondral bodies with no demonstrable intrasynovial disease. Treatments include removal of loose bodies together with the affected synovium by arthrotomy; sometimes the disc is excised when it is involved. Arthroscopy is useful for the primary treatment of SC as a less invasive treatment and removing loose bodies <3 mm.[11-15]

There are several reports about SC affecting TMJ, but they are limited.[6,16-19] More information about clin-

[a]Center for Temporomandibular Joint Disorder and Orofacial Pain.
[b]Department of Oral and Maxillofacial Surgery.
[c]Department of Oral Pathology.
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ical, radiologic, surgical, and histopathologic findings of SC in TMJ should be combined to attain comprehensive information about this lesion and provide more references for diagnosis and treatment. The purpose of the present investigation was to present and summarize our experiences with diagnosis and treatment of SC affecting the TMJ, emphasizing the MRI features.

PATIENTS AND METHODS

The clinical data of SC affecting the TMJ in Peking University Hospital of Stomatology were reviewed retrospectively from January 1990 to January 2009: 20 patients with complete records were included in the present investigation. Nineteen cases were treated with open surgery and 1 case with arthroscopy. The final diagnosis of SC was confirmed by histopathologic examinations for all 20 cases. The clinical manifestations, radiographic findings, histopathologic features, surgical treatment, and differential diagnosis were combined to study this disease. The imaging findings (conventional radiography, CT, and MRI) were evaluated by specialists in TMJ and oral radiology. Among the 20 cases, MRI was taken in 13, CT in 15, and conventional radiograph in 20. The SC features on MR images were described on proton density–weighted (PD) and T2-weighted images. The study was performed in compliance with the relevant polices of Peking University Institutional Review Board.

RESULTS

Among the 20 SC cases of TMJ, there were 12 women and 8 men. The ratio of female to male was 1.5:1. The ages ranged from 32 to 67 years (median 44 years), and the duration of symptoms was 2 months to 20 years (median 3 years). The affected sides were right 12 and left 7, and 1 case was bilateral. Pain (17/20), limitation of mouth opening (14/20), swelling of the preauricular region (13/20), and crepitations (5/20) were the chief complaints. Five patients had history of recurrent swelling and pain of the affected joint, and 3 patients had headaches. Physical examination could also find deviation of mandible on opening (14/20), tenderness (11/20), and open bite (3/20). All of the patients had no history of rheumatoid arthritis. One patient had a trauma in the chin 10 years before SC was diagnosed.

On conventional radiographs (transcranial projections or panoramic radiographs), widening of the joint spaces could be detected in 75%; bony changes of articular surfaces, including sclerosis, flattening, hyperplasia, or erosion with different degrees could be found in the condyle (65%) and glenoid fossa (45%). The positive detection rate of calcified loose bodies was only 30% (6/20) on conventional radiographs and 53.3% (8/15) on CT (Table I). However, CT could show clearly the bony erosion and extension of SC (Fig. 1). Four cases demonstrated bony destruction of skull base.

Thirteen cases of SC had MR examinations, and MRI findings are summarized in Table II. On MR

Table I. Conventional radiographic (CR; n = 20) and computerized tomographic (CT; n = 15) findings of synovial chondromatosis (SC)

	Bony changes in CR			*Calcified loose bodies*	
	Condyle	*Fossa*	*Space widening*	*CR*	*CT*
n	13	9	15	6	8
%	65%	45%	75%	30%	53.3%

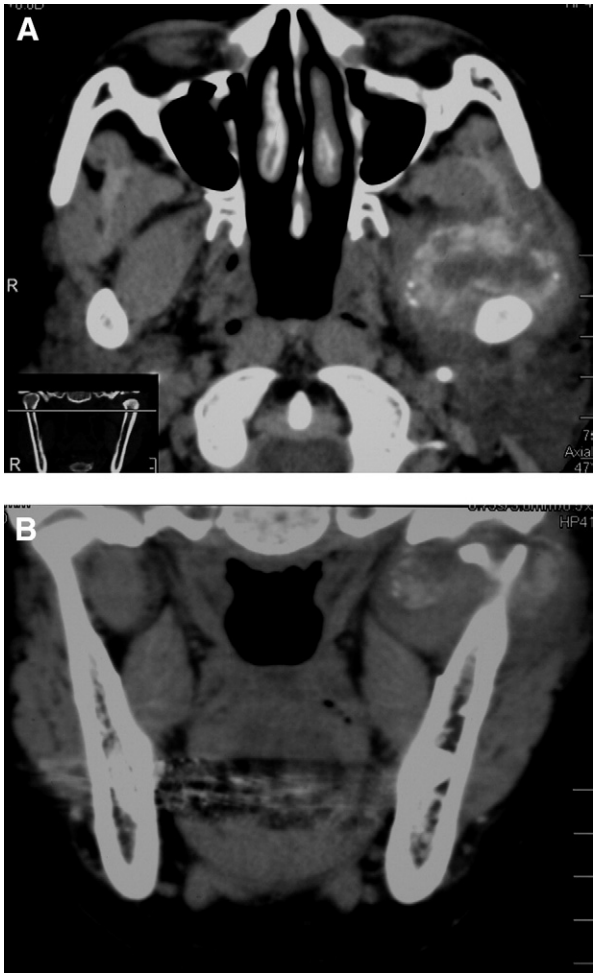


Fig. 1. Computerized tomography scans of synovial chondromatosis (SC). **A,** Irregular stippled calcifications ahead of the left condyle. **B,** SC extending into infratemporal fossa and lateral pytergoid muscle. Erosive change of the left condylar head and multiple irregular radiopaque masses surrounding the condyle.

Table II. Magnetic resonance imaging findings (n = 13) of synovial chondromatosis (SC)

			Capsular expansion		*Signal characteristics*		*Extra-articular extension*			
	ADD	*Large joint effusion*	*Db*	*Bm*	*Rs*	*Rs+Ts*	*Lat*	*Ant*	*Sup*	*Med*
n	6	12	9	4	10	3	5	3	4	3
%	46.2%	92.3%	69.2%	30.8%	76.9%	23.1%	38.5%	23.1%	30.8%	23.1%

ADD, Anteriorly displaced disc; *Db,* dumbbell; *Bm,* bulky mass; *Rs,* ring-like signals; *Ts,* tubular signals; *Lat,* lateral; *Ant,* anterior; *Sup,* superior; *Med,* medial.

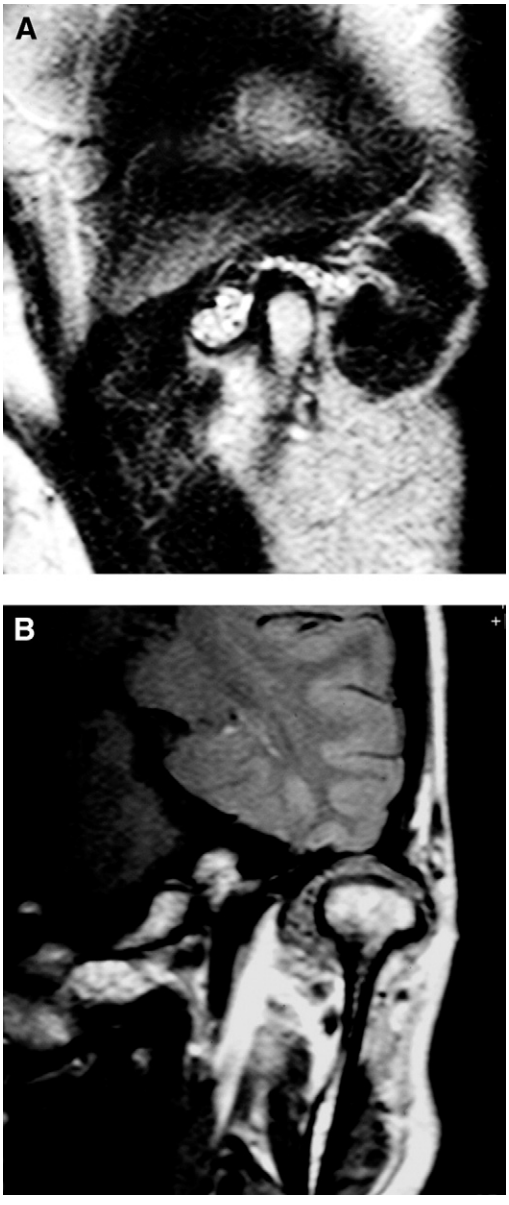


Fig. 2. Magnetic resonance images of synovial chondromatosis (SC). **A,** Saggital T2-weighted image presenting a "dumbbell-shaped" enlargement of capsule with multiple small ring-like signals within high background. **B,** Coronal proton density–weighted image demonstrating multiple small ring-like signals in the joint space.

T2-weighted images, a large amount of effusion with enlargement of capsule could often be seen, and the capsular enlargement demonstrated dumbbell or irregular shape. On MR PD images, the lesion could be shown as a dumbbell-shaped or bulky soft mass with heterogeneous signal intensities, and most importantly, multiple small ring-like or tubular signals could be seen, which consisted of low signals as the fillings and high signals as surroundings (Figs. 2 and 3). Extra-articular extensions of SC were shown in different directions on MR images (Table II). SC could extend into intracranial fossa, infratemporal fossa, and lateral pytergoid muscle (Fig. 4). Six patients (6/13) had anteriorly displaced discs.

During operations, distension of lateral capsule and visible joint effusion were often present. Multiple loose bodies, cartilaginous nodules, or fragments could be found in the joint space. The open surgical treatment consisted of removal of loose bodies and partial synovectomy of the affected areas through a preauricular approach. A discectomy was performed in 9 patients when the disc was perforated, deformed, or obviously calcified. Eight patients underwent arthroplasty (shaving), 2 had high condylectomy, and 1 had a sagittal osteotomy of ramus because severe destruction of condyle was observed. Two patients with intracranial invasion underwent a preauricular half-coronal incision to completely remove the loose bodies and to repair the perforated glenoid fossa with an autogenous temporal bone graft and interposed temporalis flap as a disc replacement. One case was treated with arthroscopy: Hyperplasia of synovium with undetached loose bodies and free floating bodies were clearly found in the superior space, and >40 loose bodies were removed by irrigation, suggesting that this case was in Milgram stage II (Fig. 5).

The final diagnosis of SC was confirmed by histopathologic examination for all 20 cases. In macroscopic appearance, multiple round and ovoid loose bodies of different sizes presented with the appearance of "grains of sand," and some small chondral nodules or fragments were conglomerated to bigger masses (Figs. 3, *C*, and 6, *C*). In microscopic appearance, SC demonstrated the following characteristics: intrasynovial

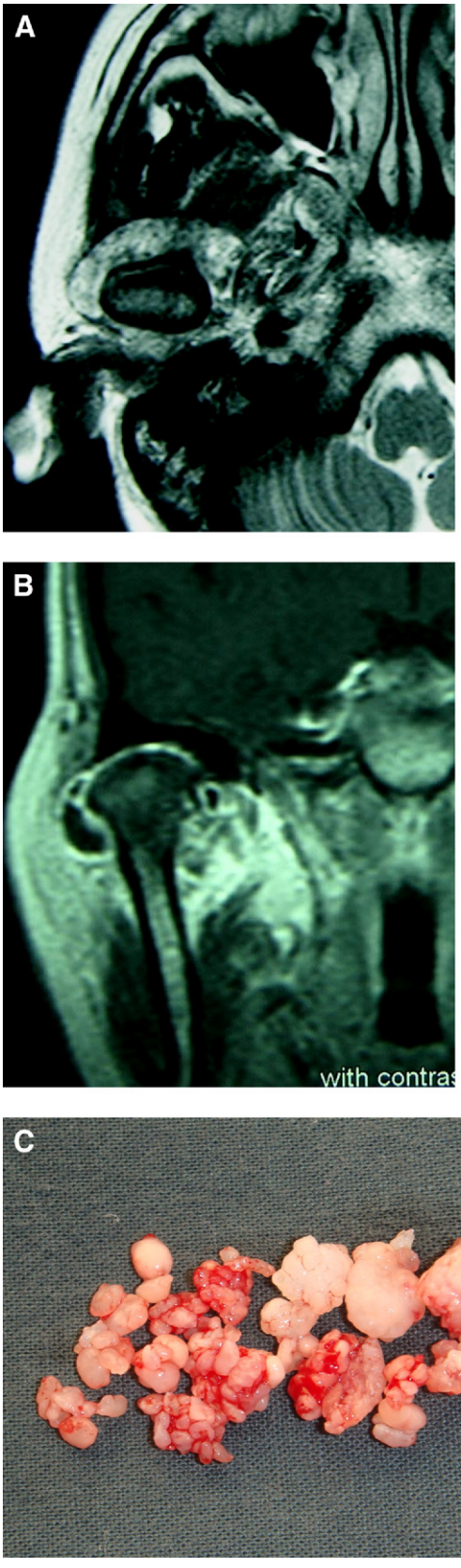


Fig. 3. Magnetic resonance images of synovial chondromatosis (SC). **A,** Axial T2-weighted image demonstrating a soft tissue mass around the condyle with multiple small ring-like signals. **B,** Synovium thickening with contrast. **C,** The chondral nodules or fragments conglomerating to bigger nodules or masses in macroscopic appearance from the same case.

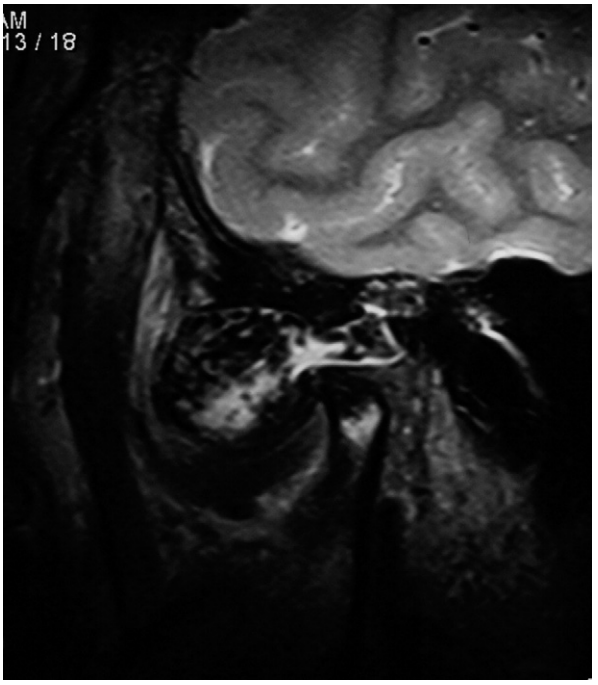


Fig. 4. Extension of synovial chondromatosis (SC). Intracranial and infratemporal extension of SC on sagittal magnetic resonance image, with dural involvement. Small ring-like and tubular signals can be seen with the bony erosion of condyle.

proliferation with partial chondrometaplasia, nodular cartilaginous proliferation arising in the synovium with calcification or ossification, nodular cartilaginous foci with fibrous encapsulation, or multiple loose nodules with calcification. Chondrocyte clones could be surrounded by irregular calcification area in the stroma, and the majority of chondrocytes showed well differentiated. Mild atypia or active growth in individual cells were observed in some cases with extra-articular extensions, and myxoid changes in the matrix were occasionally found.

All of the patients had improvement in symptoms after operation. However, 2 patients had recurrence, and a second operation was performed with extensive synovectomy and discectomy with no recurrence up to the time of writing. Three patients with destruction of skull base were thought to be recurrent in imaging: One was kept under an observation without obvious symp-

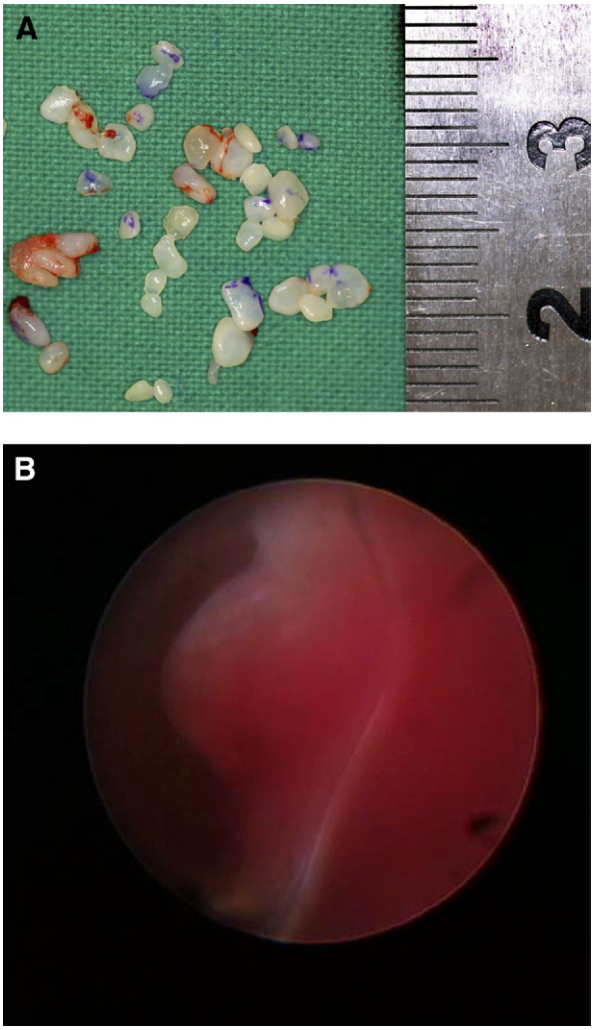


Fig. 5. Treatment of synovial chondromatosis (SC) with arthroscopy. **A,** Multiple loose bodies were removed from the superior joint space using arthroscopy. **B,** Arthroscopy also demonstrated the synovium thickening and swelling with chondral body still not detached from it.

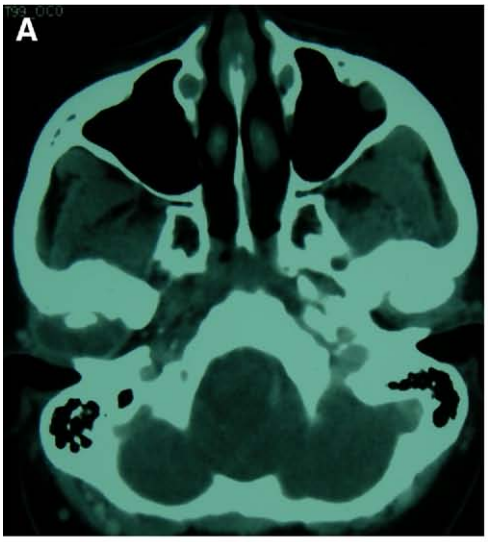
tom, and the other 2 planned to have a second operation. The patient with arthroscopy also had obvious symptoms relief and was kept under a follow-up investigation (8 months at the time of writing).

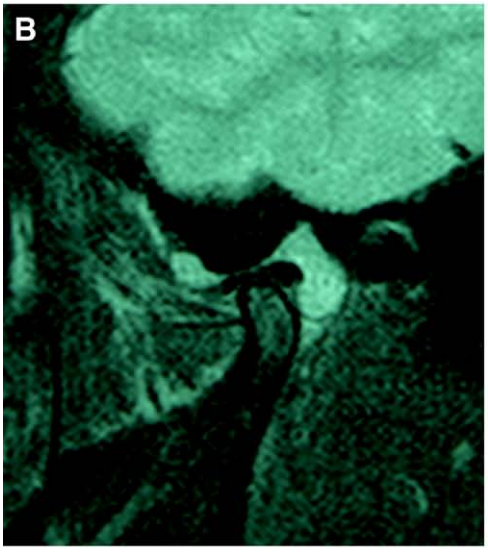
DISCUSSION

Synovial chondromatosis is a rare disease which may develop in the synovial membrane, usually of the large joints, and is very uncommon in TMJ. The present investigation indicated that this lesion occurred more often in women and on the right, according with other related reports[17] and different from SC in large joints.[1] Bilateral SC of the TMJ was occasionally reported.[20] Only 1 patient in the present group was bilateral. Symptoms include preauricular pain, swelling, limitation of mouth opening, crepitations, and deviation on opening. Headache was often complained of in the cases with intracranial invasion. Five patients had recurrent pain and swelling and seemed to be responsive to antiinflammatory agents, which supported local infection as a possible etiologic factor. However, no convincing correlation between trauma and SC was found (with 1 exception). SC of TMJ is usually confined to the joint space, but it can occasionally extend beyond the joint capsule into the cranium, parotid gland, infratemporal fossa, or external auditory meatus.[21-26] In the present study, SC affected mainly the superior joint space; it could involve in the inferior space when a perforated or deformed disc was present. Five cases extended into extra-articular regions, of which 4 cases extended superiorly with bony erosion of skull base, 3 with intracranial extension, and 3 into infratemporal fossa and lateral pytergoid muscle.

Although conventional radiographs can show widening of joint space, usually accompanied by bony abnormality, cartilaginous nodules with lack of calcification or ossification were not detectable.[27] Fifteen cases of SC in the present study had bony changes of different degrees. CT is a good choice for showing osseous abnormalities of the condyle and glenoid fossa, showing extension of SC into the neighboring regions with bony destruction[5] and showing some loose bodies that could not be detected by conventional X-rays. However, small cartilaginous nodules with lack of calcification or ossification were easily overlooked on CT scan (Fig. 6).

Magnetic resonance imaging has more advantages in the diagnosis of SC, showing changes of TMJ structure without radiation exposure, including capsule, disc position, and medullary cavity, and showing effusion, hypointensive loose bodies not well calcified, and extension of SC into neighboring structures. T2-weighted images can make a significant diagnostic contribution by demonstrating inflammatory reactions such as joint effusion and marrow edema.[28] SC on MR images in the present study demonstrated a series of findings: a large amount of effusion with capsular enlargement, synovium thickening, and a dumbbell-shaped or bulky soft mass with heterogeneous signal intensities in the joint space. The enlargement of capsule usually demonstrated a dumbbell shape, which supported the findings of Ida et al.[6] The capsular expansion with a large amount of effusion was very common in our investigations, which concurred with other authors' results.[16,18] Looking carefully over all of these cases, we found a characteristic ring-like signal on MR images of the patients with SC of TMJ. Especially on PD images, multiple small ring-like or tubular signals could be





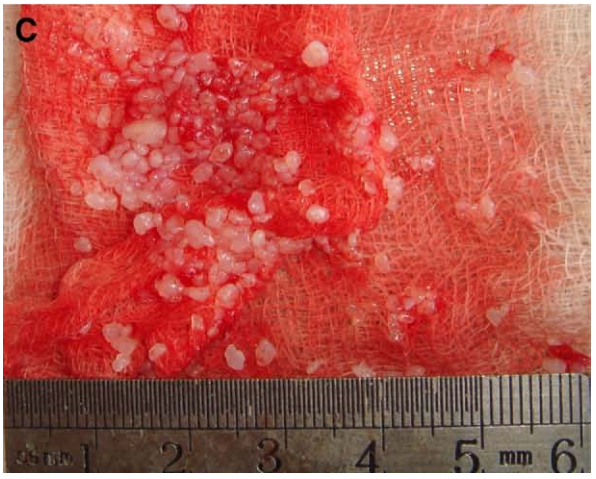


Fig. 6. One case overlooked by computerized tomography (CT) scan. **A,** Axial CT scan demonstrating a soft tissue mass with no obvious calcification around the condyle. **B,** Saggital T2-weighted magnetic resonance image of the right joint shows expansion of the capsule and areas of high signal intensity consistent with joint effusion. The small ring-like signals are present, and the disk and the condyle seem to be normal. **C,** In macroscopic appearance, loose bodies present as "grains of sand."

seen, in which the low-signal filling might stand for chondral nodules or fragments, and the high-signal surrounding might be effusion fluid or fibrous encapsulation (Figs. 2 and 3).

In addition, MRI could visualize the boundaries of the lesion with the neighboring structures, especially when it had extra-articular extensions (Fig. 4). SC could extend beyond the joint into infratemporal fossa, lateral pytergoid muscle, and intracranial fossa. Three cases with intracranial extension and dural involvement were clearly shown by MRI in the present study. Preoperative MRI studies were helpful in illustrating disease extension, distinguishing the site of origin, and guiding treatment.

The clinical diagnosis of SC depended on the imaging findings before operation. Because not all 20 cases had undergone CT or MRI, and with the limited knowledge about SC in the early 1990s, the overall agreement rate of clinical diagnosis with pathologic diagnosis was only 60% (12/20). Moreover, the stages of SC and its diversity on MR images made it difficult for primary diagnosis. Therefore, the actual incidence of SC might be higher than earlier views. The increase of SC patients in our hospital was related with using MR examination more frequently and increased knowledge of clinician about this lesion. The combination of MRI with CT or with other conventional radiography can improve the diagnostic accuracy of SC.

There are different opinions about whether SC is a neoplsam or just a chronic inflammation with metaplastic activity.[18,19] However, SC is defined as a benign nodular cartilaginous proliferation and classified as a cartilage tumor, according the World Health Organization.[1] SC is thought to be self-limiting but may recur locally after excision or incomplete synovectomy, especially in its early stage.[29,30] Intracranial extension revealed the potential aggressive behavior of this lesion. Three patients with destruction of skull base were thought to be recurrent in postoperative imaging, and in histology they demonstrated some cellular atypia with active growth of chondrocyte, suggesting that these lesions were in active stage. Malignant transformation of SC to chondrosarcoma has rarely been reported in large joints after a long history and recurrence,[31] but not in TMJ according to our knowledge. Because of

recurrences and intracranial extension, postoperative follow-up examinations for the patients were suggested, initially at 3-month intervals in the first year and later once per year.

Because of low incidence in TMJ and nonspecific symptom and signs, the primary diagnosis for some patients with atypical imaging manifestations of SC was not easy.[19] It should be differentially diagnosed first with TMJ disorder (TMD). About 0.3% of the patients complaining of TMJ pain and dysfunction were found with SC.[6] For the patients with unsuccessful conservative treatment of TMD, especially accompanied by swelling and occasional fever, further imaging examinations including CT and MRI should to be performed to exclude SC. In addition, SC has been found to coexist with degenerative osteoarthritis and sometimes condylar hyperplasia. This not only causes diagnostic confusion, but also raises the question of etiology.[32] An experimental osteoarthritis in adult monkeys has suggested a relation between SC and osteoarthritis.[33] On conventional radiographs, degenerative osteoarthritis has narrower joint space and fewer loose bodies.

Synovial chondromatosis might also be misdiagnosed as cysts or parotid masses because it can extend into extra-articular tissues,[34] especially in the early stage without free calcified bodies formed. Two of the present 20 cases were misdiagnosed as synovial cysts clinically without MRI examinations, but the postoperative histologic findings revealed SC. SC with extra-articular extension and compressing bony erosion was easily misdiagnosed before surgery as osteosarcoma or chondrosarcoma, which may manifest as a solid tumor with cortical bone destruction, but not with multiple loose bodies within the joint space.[24,35] Although a mild cellular atypia was observed in a light microscope in SC, but the hallmark characteristic of chondrosarcoma was not found, [36] which exhibited cartilaginous tissue proliferation with celullar pleomorphism, nuclear hyperchromasia and myxoid changes in the matrix.[37]

Arthroscopy is effective in diagnosis of SC, especially in precisely diagnosing the stage of SC.[11] McCain and de la Rua[12] first treated SC by arthroscopy, removing the affected synovial tissue and loose bodies. That is a less invasive alternative to open arthrotomy, but the main limitation of the technique is to operate mainly in the upper space and inability to remove the large loose bodies. In the present case treated with arthroscopy, we tried to use this technique to make a definitive diagnosis and to improve the symptoms of patient. This case was confirmed in Milgram stage II, and the symptoms were greatly improved after irrigation. Another new SC case was recently treated by arthroscopy with a symptom-free postoperative course for 4 months (data not shown). The stage of SC was thought to be a risk factor for recurrence.[38]

Considering its recurrence and the different behavior of SC in different patients, some new treatment strategies should be suggested. For the cases with aggressive behavior presented as extra-articular extensions, especially with the destruction of skull base, an open surgery should be performed as soon as possible. For the cases just with intracapsular lesion and mature loose bodies, arthroscopy could be the first choice as a less invasive treatment method to clean out the loose bodies as much as possible and relieve the symptoms. For the cases not responsive to arthroscopy, a further open surgery could be performed. Routine imaging examination, especially MRI, is critical in both of the treatment design and the follow-up investigation.

CONCLUSIONS

The clinician should have a comprehensive knowledge about SC so as to make a correct diagnosis and treatment plan. MRI examination plays an important role in finding some available signs and diagnosing SC. The imaging manifestations of characteristic ring-like signals in the joint, especially in the superior joint space, could be found on MR PD and T2-weighted images. Clinically, SC should be differentially diagnosed with TMD, chondrosarcoma, and other preauricular masses. Because of recurrences and intracranial extension, long-term follow-up is suggested. Considering its recurrence and the different behavior of SC in different patients, various treatment strategies should be considered.

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Reprint requests:

Xuchen Ma, DDS, PhD
Center for TMD and Orofacial Pain
Peking University School and Hospital of Stomatology
22 ZhongGuanCun South St.
HaiDian District
Beijing 100081
China
kqxcma@bjmu.edu.cn.