Case Report

Temporomandibular joint osteoarthritis diagnosed with cone beam computed tomography and its conservative management: a case report

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Abstract

Temporomandibular joint (TMJ) osteoarthritis is a debilitating degenerative disorder causing inflammatory conditions and osseous changes in the joints. Degeneration of the TMJ condyle can lead to malocclusion and skeletal deformity, chiefly retrognathism, accompanied by anterior open bite and facial asymmetry. This case report describes a 29-year-old female patient with symptoms of degenerative changes in the TMJ. Cone beam computed tomography images showed erosion and concavity of and subchondral cyst formation in the right condyle, loss of continuity of the articular cortical bone, and mild sclerosis of the left condyle. Occlusal pivot splint therapy and muscle relaxation training resulted in gradual and significant restoration of the erosive bony concavity and regaining of the intact cortical lining of the right TMJ condyle. Other favorable clinical outcomes included disappearance of the crepitus sound, mouth-opening limitation, and facial asymmetry. Favorable treatment responses were verified in this patient with improvement of clinical features and longitudinal osseous changes in the TMJ condyle..

Key words: cone beam computed tomography, occlusal pivot splint, osteoarthritis, temporomandibular joint

Introduction

Temporomandibular disorders (TMDs) involve the temporomandibular joint (TMJ), masticatory muscles, and/or associated structures. Possible conditions that affect the TMJ include disc displacement, TMJ sounds, congenital malformation, and degenerative joint disease[1]. Osteoarthritis (OA) is a degenerative condition of the joint characterized by deterioration and abrasion of articular tissue and concomitant remodeling of the underlying subchondral bone due to the overloading of the remodeling mechanism[2–4]. Symptoms of TMJ OA include pain, joint sounds such as crepitus, joint stiffness, restriction of mandibular movement[5,6], and most critically, joint deformity that can be recognized through radiographic imaging[7]. Osseous changes of TMJ OA involve erosion, joint mice , subchondral bone cysts, flattening, sclerosis, and osteophyte formation. Degeneration of the TMJ condyle can lead to malocclusion and skeletal facial deformity, chiefly retrognathism, accompanied by anterior open bite and facial asymmetry. Clinical evidence of the disease is seen in 8–16% of the population[8] and may be unilateral or bilateral. The disease shows high prevalence among women[9], which may be due to estrogen receptor alpha polymorphisms, and is associated with increased susceptibility to pain in female TMJ OA patients[10].

In the early stages of disc derangement, signs of osteoarthritis are not manifest; moreover, it may persist for many years without development of radiographically perceptible changes or symptoms. Disc derangement in later stages may possibly parallel osteoarthritic changes but they may also represent independent processes[11], and 50% of patients will show some active cellular osteoblastic or osteoclastic activity[12]. Risk factors of OA include age, genetics, trauma, disturbances of joint or muscle, and systemic conditions; the etiology is complex and multifactorial[13,14]. Its etiopathogenesis involves a sustained inflammatory process leading to early damage to the cartilage due to metabolic and mechanical factors[15]. A series of biomechanical changes initiated in the hard and soft tissue of the joint triggers the immune response. Various inflammatory mediators, such as cytokines and chemokines, are released coupled with the activation of the complement system by the release of cartilage-degrading factors, such as matrix metalloproteinases and prostaglandin E, which further damage the articular cartilage. The initiation of a local inflammatory response results in the eventual degradation and abrasion of joint cartilage and the remodeling of the subchondral bone[14].

The TMJ condyle is surrounded by various structures that make detailed visualization of the bony status with plain radiography difficult. In a relatively short period, cone beam computed tomography (CBCT) has emerged as a cost- and dose-effective imaging modality for diagnostic evaluation of a variety of TMJ conditions in multiple dimensions. CBCT is superior to conventional radiographic examinations and magnetic resonance imaging (MRI) for the assessment of osseous TMJ abnormalities. However, it should be emphasized that the diagnostic information obtained is limited to the morphology of the osseous joint components, cortical bone integrity, and subcritical bone destruction/production. Therefore, MRI is the method of choice for evaluation of soft-tissue abnormalities and inflammatory activity in patients with TMDs[16].

The treatment of TMJ OA should be directed at suppressing the active inflammatory process, preserving function, preventing further deformity, and relieving pain[14]. Recently, invasive methods have become increasingly popular despite little scientific evidence of their effectiveness compared to that of noninvasive treatments[5]. Minimally invasive treatments include procedures that involve application of corticosteroids, local anesthetics, and plasma-rich growth factors into the joint[17], as well as arthrocentesis in combination with hyaluronic acid injections[18]. Noninvasive treatments include patient education about different relaxation techniques, physical therapy, interocclusal appliance therapy, and medications for alleviating symptoms. Occlusal stabilization splint therapy and nonsteroidal anti-inflammatory drug administration show a significant and positive long-term effect on the prognosis of TMJ OA; however, they can be accompanied by pain, indicating unfavorable prognosis with additional bone destruction[19].

Aging increases the level of calcium in the articular disk; therefore, it becomes stronger but less elastic and less able to deal with overload[14,20]. However, severe cases of OA may be found in a much younger population, particularly women of around 35 years of age. These patients tend to have a history of macrotrauma. Furthermore, female reproductive hormones, especially estrogen with its influence on the catabolism of cartilage–fibrous tissue of the joint, may play a special role in the development of OA[21]. However, the etiology and pathophysiology of OA is not clearly defined and its initiation is complex and depends on many external and internal risk factors. We report the case of a 29-year-old adult female with symptoms of degenerative changes in the TMJ. This case report presents the goals and possibilities of conservative therapy for OA and demonstrates how severe cases of OA can also be found in the younger population.

Case report

The 29-year-old female patient was referred from the local orthodontic clinic for evaluation of TMJ before orthodontic treatment. The patient reported persistent clicking noises during normal functional movements and chewing pain for more than five years; moreover, fully opening the mouth was occasionally difficult. A routine digital palpation of the masticatory muscles elicited pain in the bilateral temporalis, masseter, sternocleidomastoideus, and posterior cervical muscles (e.g., the splenius capitis and trapezius). Crepitus of the right TMJ was detected with palpation and the limited opening of the mouth was found, with it opening unassisted only for 36 mm. The application of the end-feel test failed to increase the interincisal distance. During mouth opening, pathway deflection to the right side without returning to the midline was observed. Signs of clenching over the buccal mucosa and tongue border were inspected. A diurnal parafunctional habit was acknowledged by the patient.

Digital palpation of the bilateral TMJs when the mandible was stationary and during dynamic movement did not cause tenderness. Examination of the habitual intercuspal position showed that the chin was deviated to the right by 3 mm from the facial midline. During attempts to guide the mandible into centric relation, the chin shifted to coincide with the facial midline. Panoramic radiography analysis revealed that the patient's teeth 36 and 46, which were missing for a long time, were without prosthodontic restoration. Teeth 18 and 28 were erupting, while teeth 37, 38, 47, and 48 were mesially tilting. Panoramic radiography showed mild flattening and a little short of right condyle (Figure 1). Since panoramic radiography has limited display options for the degree and severity of bone destruction, CBCT was used to diagnose osteoarthritis of the TMJ. CBCT images were acquired using KaVo 3D eXam (KaVo Dental GmbH , Biberbach, Germany) with 0.5-mm focal spot size and 0.2-mm voxel size. Corrected sagittal, coronal, and axial images of the TMJs were reconstructed along the true axes of the mandibular condyle at a slice thickness of 0.25 mm. The coronal view of the right condyle showed erosion, concavity, and subchondral cyst formation; in addition, loss of continuity of the articular cortical bone and mild sclerosis of the left condyle were observed (Figure 2). TMJ OA was diagnosed based on the identification of typical osteoarthritic changes in the TMJ articular surface.

The patient was instructed to restrict jaw movement to within painless limits, especially when yawning. A soft diet was initiated, along with slower chewing and smaller bites. An occlusal pivot splint was fabricated from hard acrylic resin. The 2-mm thick splint allowed only a single contact between the teeth, i.e., posteriormost contact between the opposing second molars, by repositioning the mandible to the centric relation position. The patient was instructed to wear the splint during the night and was informed that the teeth should be positioned without contact, except during chewing and swallowing. The patient was asked to make a conscious effort to keep the teeth apart during all waking moments and to keep the jaw-elevator muscles relaxed when the splint and teeth came into contact. The patient was followed up every two months for two years after the splint was prescribed. After regular wearing of the splint for about four months, the mouth opening measured 43 mm without a deviated pathway. Mild muscle tightness was felt during palpation and chewing hard food. Palpation of the lateral condyle pole did not cause pain, and crepitus of the right TMJ disappeared. After 18 months, during observation of the mouth-closing pathway, the chin shifted to automatically coincide with the facial midline without guiding the mandible. Longitudinal bone changes due to TMJ OA were evaluated between the first and the two-year follow-up CBCT image sets (Figure 3). Restoration of the erosive bony concavity led to the gradual recovery and regaining

Figure 1. The panoramic radiography showed mild flattening and a little short of right condyle

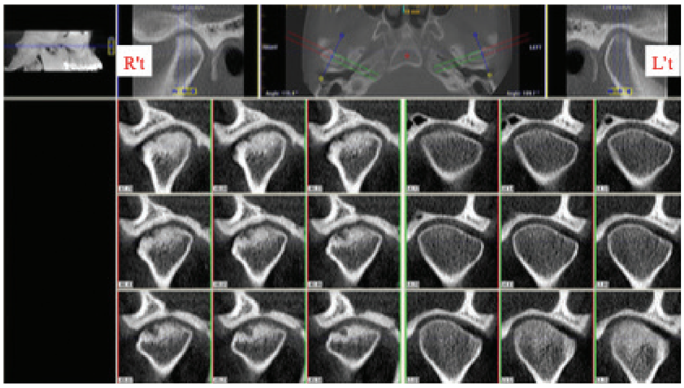

Figure 2. Osteoarthritic changes of the TMJ on CBCT showed the coronal view of right condyle with erosion, concavity and subchondral cyst formation; loss of continuity of the articular cortical bone and mild sclerosis of left condyle

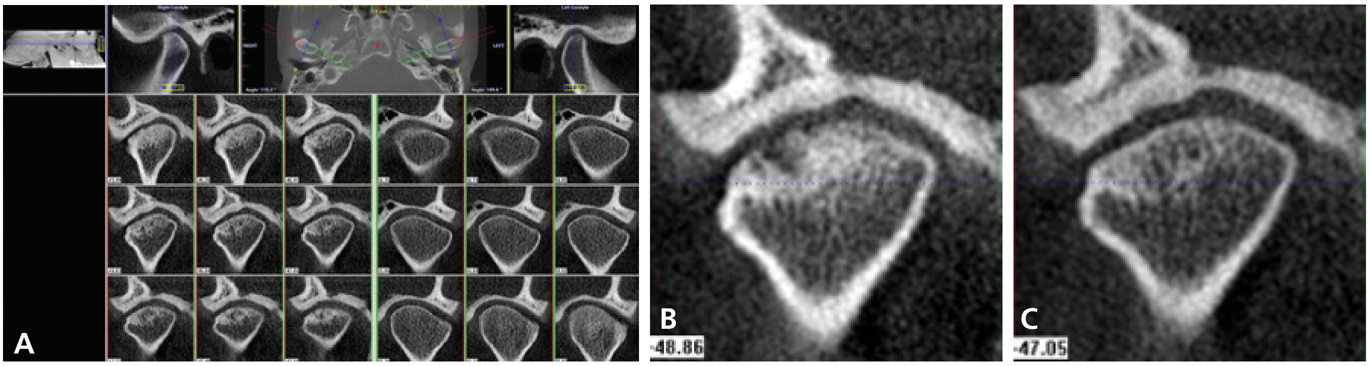

Figure 3. Follow-up CBCT image after two years (A), longitudinal bone change was evaluated between initial (B) and follow-up image (C) displayed restoration of erosive bony concavity gradually recovered and regained intact cortical lining of right TMJ condyle.

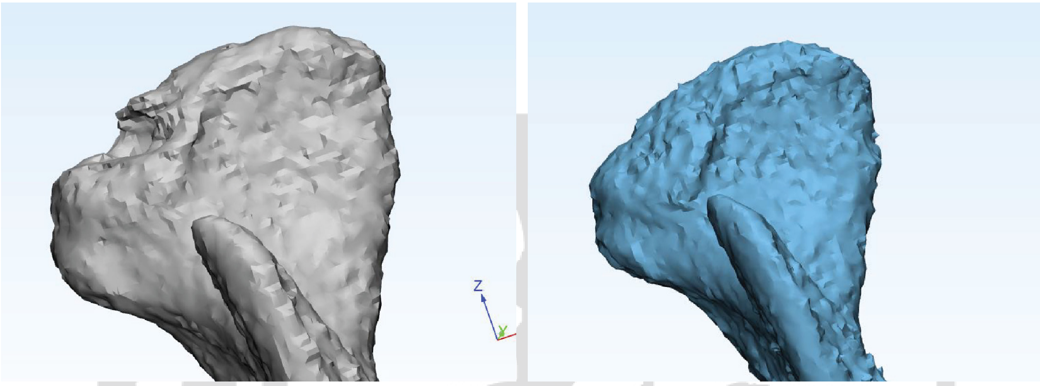

Figure 4. MIMICS software for segmentation and a 3D model of the right TMJ condyle head acquired could be used to display the quantity of bone formation.

of the intact cortical lining of the right TMJ condyle. These DICOM image files of CBCT were input into MIMICS software (Materialise's Interactive Medical Image Control System, Belgium) for segmentation, and a 3D model of the right TMJ condyle head was used to display the quantity of bone formed (Figure 4). Long-term assessment of clinical and radiographic data focusing on longitudinal osseous changes showed good clinical outcomes. Dental procedures such as orthodontic treatment and fixed partial denture fabrication can be prescribed for this patient in the future.

Discussion

Temporomandibular joint OA is a relatively common phenomenon in patients complaining of TMD symptoms, but it can also be incidentally identified during the course of any dental procedure. Deformity of the TMJ condyle due to OA can be easily visualized and confirmed with imaging modalities, such as CBCT, which provides high-resolution multiplanar reconstruction of the TMJ[22] with a low radiation dose and without superimposition of the bony structures. CBCT improves qualitative analyses of the condylar surface and detection of the condylar shape. The most common radiographic findings are flattening, erosion, and osteophytes, followed by sclerosis. OA is generally considered an age-related condition and is found predominantly among females; however, the linear correlation between bone change and age observed for other joints is not observed for the TMJ. TMD is most prevalent in young adults in their 20s to 40s; TMJ OA may begin at a very early age[23,24].

Song et al. analyzed longitudinal serial CT image sets of TMJ OA with a mean follow-up period of 644 ± 325 days; therefore, resolution of the destructive changes could be observed in numerous cases (42% of total evaluated joints)[19]. Lei et al. found a 62.7% (42/67) regeneration rate of the TMJ condyle in young adults with early-stage OA—78.1% in the anterior repositioning splint treatment group (25/32) and 48.6% in the control group (17/35)[25]. These results demonstrate that the TMJ with erosive destruction of condyle surfaces, which generally appears as sclerosis and flattening of the condyle morphology in radiographic images, can gradually recover and regain an intact cortical lining over an extended period. In the nondestructive remodeling stage without surface erosion or subchondral bone cysts, the condyle may be expected to endure the loading that occurs during daily jaw functioning, without progressive inflammation[26].

Temporomandibular joint OA has also been investigated in asymptomatic patients with different dentofacial deformities. Results showed that OA was more frequent among those with skeletal jaw discrepancies (Class II patients, in particular) than among those without jaw discrepancies[27]. Patients with TMJ OA accompanied by pain may show additional osseous destruction, which must always be evaluated in the initial diagnostic process and treated more aggressively to control the pain. Inflammatory cytokines directly evoke pain and also contribute to the additional osseous changes of the condyle; this suggests a shared pathway between pain transmission and bone resorption[28]. Cevidanes et al. showed that the extent of resorptive changes in the OA condyle is closely related to the duration and severity of pain[29].

The young patient in this case report presented with osteoarthritic changes accompanied by crepitus, facial asymmetry, and limited mouth opening. The primary therapeutic goal was to resolve the crepitus and increase the range of motion. The patient was treated with a combination of pivot splint and muscle relaxation training and was seen at followed-up consultations every two months. At four months of follow-up, the patient reported improved symptoms, including a straight mouth-opening pathway without deviation and clicking sounds, a normal range of motions, and no joint pain. Facial asymmetry was improved due to deviation of the chin to coincide with the facial midline and about a 1-mm offset from the habitual intercuspal position. Chang et al. clarified that the action of the pivot splint, which distracts the condyle away from posterior attachment tissue (in the case of displaced disk), is due to the net clenching forces located anterior to the pivot. Therefore, we expected a reduction in unfavorable upward stresses in the TMJ[30]. If the disk is in place and is being abused by a clenching or bruxing habit, distraction of the condyle would allow for a loose-pack joint position and a decrease in harmful stimuli[31]. Favorable treatment responses were verified in this patient with improvements in clinical features and longitudinal osseous changes of the TMJ condyle.

Several treatment modalities effective for improving the symptoms of TMD were investigated in previous studies. Behavioral modification, physical therapy, medication, occlusal splint therapy, intra-articular injection, and surgical procedures have been applied to manage TMJ OA[32–35]. However, few studies investigating treatment efficacy have focused on bone changes in TMJ OA. Song showed that occlusal stabilization splint therapy and nonsteroidal anti-inflammatory drugs have a significant influence on TMJ OA prognosis[19]. When weighing treatment options for TMD, invasive methods should be considered only for a small percentage of patients that do not respond to less invasive therapy.

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