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Changes of temporomandibular joint on Cone Beam CT

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Abstract: *Chronic periodontitis is a common chronic infectious disease, which can cause the destruction of periodontal support tissue, even the loss of teeth and the disorder of oral and maxillofacial system. Oral and maxillofacial system is the general name of various structures including oral and maxillofacial tissues, such as teeth, temporomandibular joint, masticatory muscles, nerves, etc., which is a functional whole with mutual restriction and coordination. The temporomandibular joint (TMJ) is an important joint in human body, which plays a crucial role in mandibular movement during chewing, swallowing and speaking [1]. At present, many studies have examined the temporomandibular joint (TMJ) in patients with occlusal disorders and dentition defects, and found that these adverse effects would cause structural changes in TMJ. However, there are few studies on TMJ in patients with chronic periodontitis. This paper will review the morphological and structural changes of TMJ in different patients.*

Keywords: *Chronic periodontitis, Temporomandibular joint condyle, Cone beam CT*

1. Temporomandibular joint

The temporomandibular joint (TMJ) is the most delicate and bilaterally linked joint in the human body, one on the left and one on the left to form a functional unit, which jointly completes the functions of chewing and swallowing, speech and expression. The bony component of TMJ is composed of temporal bone joint fossa and joint tubercles and mandibular condyles, which are separated from the temporomandibular articular surface and the mandibular condyle by the articular disc, and the external complement is coated with the joint capsule and the internal and external ligaments of the capsul, the medial, lateral and posterior are limited by the joint ligaments, with a unique structure and complex function, the temporomandibular joint is a stressed joint, and its articular surface is inconsistent. In the process of human evolution, due to the uprightness of people, the fineness of food, and the expansion of the skull, the anatomical structure of the temporomandibular joint and jaw has undergone obvious changes, and the condyle of modern humans has become significantly smaller, the corresponding condyle neck has become thinner, and the relative joint fossa is significantly larger than the condyle, so that the condyle can not only slide forward freely, but also do lateral and backward activities. Modern people also have lower joint tubercles, shallower fossas, and longer anteroposterior diameters, allowing the condyles to slide more forward.

2. Examination and diagnosis methods

There are a variety of imaging methods to examine and diagnose the temporomandibular joint, such as x-rays, curved tomography, cone beam tomography (CBCT), magnetic resonance imaging (MRI), etc. [2]. Of all methods, CBCT images are considered very useful in joint visualization of the temporomandibular joint, providing a good representation of condyle anatomy, its variation, and its adaptability to functional stimuli[3]. CBCT has a special device for fixing the patient's head, which can ensure the success rate of scanning and image clarity. Grayscale and contrast can be adjusted during image analysis, and the image of the bony structure of the temporomandibular joint will be displayed more clearly, in addition, it has the advantages of three-dimensional imaging, high image resolution, few artifacts, low radiation dose, fast data acquisition speed, low price, etc.

CBCT can visualize temporomandibular joint structures from coronal, sagittal, and tranverse

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positions, and obtain joint spaces in different orientations; It can measure the horizontal angle, height, radius, volume and surface area of TMJ condyles, so as to understand the anatomical morphology of condyles, which is conducive to the clinical analysis of TMJ condylar bone changes. It can effectively measure the bone thickness of the joint fossa roof, as well as the height of the TMJ tubercle and the slope of the joint tubercle [4]. 3D imaging of CBCT improves the accuracy of linear measurements (width, length, and height) of the mandibular condyle [5]. It is used to study the three-dimensional structure of the condyle of the mandible. In addition, CBCT is very stable for measurement of joint space [6]. In short, CBCT can significantly improve the clinical ability to diagnose temporomandibular joint diseases and effectively guide the clinical treatment of them.

3. Chronic periodontitis

Periodontitis is a chronic infectious disease that begins and maintains plaque microorganisms, involving the soft and hard tissues around the teeth, chronic periodontitis is the most common type of periodontitis, the course of chronic periodontitis is a slow process, there may be changes in the joint force, lateral chewing and other adverse consequences. As the severity of the disease increases, the alveolar bone resorbs, and the teeth become loose, displaced, or even fall out [7]. Alveolar bone resorption due to severe periodontitis remains the leading cause of tooth loss in adults [8]. These clinical manifestations may lead to temporomandibular joint disorder (TMD).

4. Changes in the temporomandibular joint

4.1 Effect of occlusal factors on TMJ

The oral and maxillofacial complex consists of a number of anatomical structures, such as the temporomandibular joint, masticatory muscles, teeth, periodontal tissue, and nerves and blood vessels, which precisely coordinate the entire masticatory system [9]. The bite of the teeth is critical to the stability of the oromaxillary system, including the teeth, masticatory muscles, and temporomandibular joints. Malocclusion of teeth can lead to instability of the oromaxillary system and play a role in the etiology of temporomandibular joint disorders [10].

The bite has an important guiding effect on the masticatory movement, and feedback regulates the contractility of the masticatory muscles, and the central nervous system can also regulate the contraction of the masticatory muscles, thereby regulating the load on the temporomandibular joint. There are a large number of studies in the literature on the relationship between occlusal type and temporomandibular joint morphology, among which the relationship between anterior tooth overlay relationship and joint nodule slope has attracted attention, which essentially reflects the indirect regulation effect of occlusal on temporomandibular joint load. The temporomandibular joint responds to changes in load by histologic modifications, such as local tissue hyperplasia or resorption, and the rebuilding of obvious sites can exhibit anatomical morphological changes.

The dentition is the anatomical basis of occlusion, the occlusal surface of the tooth is the main functional part of the masticatory movement, and tooth loss is the most common abnormal occlusal factor [11]. Tilting of adjacent teeth between missing teeth and elongation of jaw teeth can cause occlusal disorders such as occlusal interference or early contact [12]. The bite determines the pattern and position of the mandible, and occlusal instability may be one of the causes of excessive loading of the masticatory system, which may also lead to damage to the temporomandibular joint. [13] Destruction of periodontal tissue and loss of teeth eventually leads to a range of adverse outcomes for the oral and maxillofacial area, such as temporomandibular joint disorders (TMDs). Because premature contact is more common in patients with TMJ disorder than in healthy controls, this can lead to condyle displacement, which may lead to changes in temporomandibular joint structure due to friction, increased intra-articular pressure and muscle tone, and bilateral occlusal force asymmetry [14].

4.2 Effect of dentition defects and deletions on TMJ

The temporomandibular joint is subjected to compressive stress during both combined and chewing movements, and this stress does not act uniformly on the joint. There are numerous studies that suggest a link between tooth loss and temporomandibular joint dysfunction [15]. Ahmed Naglaa et al. measured and evaluated the condyles of 100 subjects (50 of whom were Kent's class I patients and 50 were with intact dentition) by CBCT, and found that the average width of the condyles in the Ken's class I group was significantly higher than that of the control group, but the average condyle height was significantly lower than that of the control group, and the results showed that the loss of posterior teeth significantly reduced the condyle height and increased the width significantly [16].

Animal experiments have also shown that the posterior teeth of developmental rats are extracted and measured after 8 weeks after the bone matures, and the results show that the loss of posterior teeth causes skeletal development disorders, resulting in smaller mandible length and joint space [17]. Most scholars believe that the loss of posterior teeth not only affects the functions of chewing, speech, and aesthetics, but also affects the stability of the temporomandibular joint. Mundt et al. conducted a case-control study of 82 asymptomatic control groups and 263 patients with temporomandibular arthropathy using magnetic resonance imaging and found a positive correlation between disc displacement and the number of missing teeth in posterior teeth [18]. A study analyzed the functional status of the temporomandibular joint and the number and distribution of missing teeth, and statistically showed that there were 521 missing teeth, of which 146 were maxillary first premolars, and the number of missing teeth in the dysfunction group was large. This suggests that there is a link between the loss of maxillary first premolars and temporomandibular joint dysfunction, and that the loss of upper first premolars may contribute to TMJ dysfunction to some extent, and temporomandibular joint dysfunction predisposes to the loss of maxillary first premolars [19]. Reduced vertical distance of edentulous jaw occlusion has been found to lead to asymmetrical changes in the position of the bilateral condyles [20].

4.3 Effects on TMJ after denture restoration

Long-term failure to repair missing teeth, staggered tooth tips when chewing, non-missing teeth in contact, changes in the activity of the lower jaw biased to the healthy side, inconsistency between tooth position and masticatory muscle position, not only directly affect the chewing efficiency, but also lead to a decrease in vertical distance, resulting in unbalanced bite, affecting neuromuscular adaptability. The goal of repair is to achieve a good occlusal relationship and maintain the normal physiological function of the oral and jaw system. In 20 patients with temporomandibular joint disorder after denture repair as the research object, CBCT examination was performed to measure the data of temporomandibular joint, condyle and space before and after the patient's repair, and it was concluded that the longer the patient's missing teeth, the more the vertical distance decreased, the greater the distance of the condyle upward movement, so the greater the vertical distance required for recovery, so it was clinically recommended that the vertical distance of the restoration of dentures was best controlled at about 4mm [21].

4.4 Lateral chewing

Studies have found that the temporomandibular joint is stressed more when the mouth is open than when the mouth is closed, and the pressure on the working side joint is less than the pressure on the non-working side when chewing laterally. Long-term loss of teeth will also change the habit of chewing, and there will be an imbalance in the motor function of the muscles on both sides. Hemichewing may visualize condylar morphology, interarticulate spaces, and nodular morphology in asymptomatic people with TMJ [22-23].

When chronic periodontitis progresses, discomfort caused by inflammation may prompt patients to chew unilaterally and have unbalanced movements, resulting in abnormal occlusal relationships and even occlusal trauma, thereby affecting temporomandibular joint function, resulting in retrograde condyles, deviation of the midline, and temporomandibular joint disorder [24]. Some scholars conducted CBCT examination on 35 people with left chewing habits, 38 people with right chewing habits and 48 people with unbiased chewing, and found that there was no significant difference in the morphology of bilateral temporomandibular joints in people with non-partial chewing habits, and the width of the sagittal and coronal surfaces of the neck of the non-habitual lateral condyle of the hemimastic masticators was greater than that of the habitual side, which proved that the load of bilateral temporomandibular joints in those with hemimastic habits was different, thus affecting the bone morphology of the condyle [25].

4.5 Chronic periodontitis

Some scholars divided 50 patients with chronic periodontitis into mild, moderate and severe periodontitis groups, and used CBCT to analyze the bilateral temporomandibular joint joint, and the results showed that the bilateral temporomandibular joint supra-space was asymmetrical, and the difference between the joint space of patients with different degrees of periodontitis at 90 °in the sagittal position was statistically significant, and there were also differences between the inner and outer diameters of the condyle in patients with severe chronic periodontitis. In addition, he proposed the following points: chronic periodontitis is associated with changes in the structure of the temporomandibular joint; TMJ examination is clinically meaningful in patients with chronic periodontitis; The temporomandibular joint, masticatory muscles, and periodontal tissues are closely connected [26].

Foreign studies have examined the temporomandibular joint in patients with temporomandibular joint disorders caused by lateral chewing caused by chronic periodontitis, and concluded that unilateral chewing caused by chronic periodontitis not only causes pain, but also causes changes in the structure of the temporomandibular joint if not treated in time [27]. The authors recommend immediate treatment of chronic periodontitis, which prevents not only the development of periodontitis, but also secondary temporomandibular joint related problems. In addition, temporomandibular joint examination should be performed in participants with chronic long-term periodontitis who have not been treated.

5. Prospect

In highly developed social environments, people are emotionally and psychologically stressed, and stress can increase susceptibility to periodontal disease. Psychological stress and nervousness increase the secretion of adrenaline, inhibit the body's immune defense function and thus develop periodontitis, which is also one of the risk factors for temporomandibular joint disorders. Common temporomandibular joint diseases include temporomandibular joint disorder (TMD), temporomandibular joint rigidity and joint dislocation, and conical beam CT has important value in the diagnosis of such diseases.

Among them, temporomandibular joint disorder disease is the most common, and it has been believed that the occurrence and development of this disease are related to anatomical factors such as psychiatric factors, occlusion factors, immunity, asymmetric development of bilateral joints, as well as lateral chewing, bruxism and other bad oral habits. Through CBCT examination, it was found that most TMDs had changes in the joint space, condyle smoothing and shortening, condylar osteosclerosis, joint nodules, joint fossa sclerosis and other bone changes.

At present, there are few studies on the structure of temporomandibular joints in patients with chronic periodontitis, and the relationship between periodontitis and TMJ anatomical changes is still unclear, and whether these changes are consistent with TMJ changes caused by loss of dentition, lateral chewing, etc. Therefore, the next study used conical beam CT to preliminarily quantify the changes of TMJ in patients with chronic periodontitis, and correlated the imaging findings with changes in TMJ structure and the severity of chronic periodontitis, aiming to explore whether chronic periodontitis has an effect on TMJ anatomy.

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