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Research progress on CBCT of temporomandibular joint morphology in children with malocclusion in mixed dentition

Munire Tuerxun[1], Yinghao Jing[1], Yishan Liu[1,2,*]

[1]Department of Pediatric Dentistry and Preventive Dentistry, the First Affiliated Hospital of Xinjiang Medical University, School/Hospital of Stomatology, Xinjiang Medical University, Urumqi, 830054, Xinjiang Uygur Autonomous Region, China
[2]Stomatological Research Institute of Xinjiang Uygur Autonomous Region. Urumqi, 830054, Xinjiang Uygur Autonomous Region, China
**Corresponding author: LYS-tree@126.com*

Abstract: *Malocclusion is an abnormal development and deformity of maxillofacial structure caused by congenital factors or acquired factors. The morphology and structure of the temporomandibular joint with various malocclusion deformities have their own characteristics, which can seriously affect the physical and mental health of children. With the continuous development of society and economy and the gradual improvement of people's living standard, malocclusion malocclusion in children during dental replacement period has received more attention. CBCT is one of the important imaging methods to examine the morphology and structure of temporomandibular joint. In order to intervene early in children with malocclusion during mixed dentition and to understand the morphological and structural characteristics of temporomandibular joint, imaging is used to review the morphological and structural characteristics and differences of temporomandibular joint in children with different types of malocclusion during in mixed dentition.*

Keywords: *mixed dentition, malocclusion, temporomandibular joint, CBCT*

Malocclusion deformity is a maxillofacial deformity caused by various internal and external factors in the process of growth and development. In addition to caries and periodontal disease, common diseases affecting human oral health are manifested as maxillary lordosis, mandibular retraction, crowded and uneven teeth, which are the main complaints of parents taking children for treatment[1, 2]. Malocclusion deformity not only affects facial appearance, self-esteem and psychological development of children [3], but also affects chewing function, growth and development of children, and health and function of oral-maxillary system and temporomandibular joint [4, 5]. In the field of oral diseases, malocclusion has always been the focus of oral disease research at home and abroad, and there has been an obvious rising trend in recent decades. In China, malocclusion has a high prevalence rate [1, 6]. Studies have found that the prevalence rate of malocclusion in children and adolescents is 56%[7], and childhood is an important period for tooth and bone changes [8]. Early diagnosis and treatment of developing malocclusion can yield both short and long-term benefits and can induce occlusion to achieve physiological occlusal and maxillofacial aesthetic goals [7]. Therefore, in the growth process of children, doctors, parents and teachers need to make joint efforts, early detection and treatment, remove the causes, guide the normal development of jaw bone and temporomandibular joint, and cultivate a comprehensive and healthy child.

Temporomandibular joint is one of the most indispensable joints in the human body and plays an important role in chewing, speaking and swallowing every day [9]. The morphological structure of the temporomandibular joint and the position of the condyle in the articular fossa will affect the growth, development and direction of the mandible in children during the growth peak period, and its morphological structure also plays an important role in the long-term stability of treatment[10]. In recent years, with the development of imaging technology, Cone-beam computed tomography (CBCT) has made new progress in temporomandibular joint imaging technology, which determines the position and symmetry of the anatomical structure from multiple angles. Defects such as cephalic overlap and scaling errors in the traditional two-dimensional projection method can be avoided [11], and the morphological structure and condyle position of temporomandibular joint can be described more accurately. There are many studies on the relationship between dental malocclusion and

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temporomandibular joint, but few studies on sagittal malocclusion and temporomandibular joint caused by different growth types[10], and even fewer studies on children with malocclusion during in mixed dentition. In this paper, the morphological and structural characteristics and differences of temporomandibular joint in children with different types of malocclusion during denture replacement are reviewed by imaging, so as to compare the differences among them.

1. Malocclusion and temporomandibular joint

Temporomandibular joint is a complex joint that continuously responds to various functional factors and forces. The morphology and structure of condyle and articular fossa are irregular and changeable, and there are also great differences between patients with malocclusion with different sagittal orientation and children of all ages [12,13]. Therefore, condyle and articular fossa morphology should be paid attention to in orthodontic treatment plan. As one of the basic structures and growth centers of the temporomandibular joint, condyle is closely related to the jaw[14]. The most unstable parts of the reconstruction of the temporomandibular joint are also condylar cartilage and subchondral bone. Relevant studies have shown that the morphological difference between condyles and condyles is the most obvious in the structural morphology comparison of temporomandibular joint with different malocclusion deformities[15]. Many studies at home and abroad have proved that there is a close relationship between the morphological structure of temporomandibular joint with various malocclusion malocclusion. In the process of orthodontic treatment, it is extremely important to understand the morphological structure of temporomandibular joint in children with different types of malocclusion when making plans, treatment objectives and objective evaluation of treatment effects[16].

2. Imaging examination of temporomandibular joint

Temporomandibular joint (TMJ) has complex anatomical morphology and physiological functions. Imaging examination is the main examination means of temporomandibular joint, which can accurately and clearly reflect the joint structure, fossa morphology and condyle location, so as to analyze the morphological and structural characteristics of temporomandibular joint in different types of patients[17]. In past studies, various devices were used to examine the temporomandibular joint, such as CT, magnetic resonance imaging (MRI) and CBCT. The traditional two-dimensional projection of temporomandibular joint can not accurately display the three-dimensional morphology of temporomandibular joint, and its clinical application is limited. MRI is considered as the gold standard diagnostic method for TMDS. Although MRI has high specificity for tissues around temporomandibular joint, especially soft tissue, it has low resolution for bone tissue. Therefore, it is not the best choice for the examination of temporomandibular joint structure and condyle morphology in patients with malocclusion. MRI examination has disadvantages such as relatively long scanning time, machine noise and prolonged mouth opening, which bring fear and discomfort to children. Children cannot cooperate well in the examination, and its examination cost is higher than that of X-ray film and CBCT, which is generally unacceptable to patients. CT is considered to be an accurate diagnostic imaging technique for evaluating temporomandibular joint, but CBCT is preferable due to its lower radiation dose and shorter scanning time[17]. Conical beam CT (CBCT) is widely used in the examination of oral diseases[18], and also in the diagnosis and research of temporomandibular joint diseases[19]. Nakajima et al. found that CBCT could provide three-dimensional images of the temporomandibular joint, in which the bone structure could be clearly observed [20]. In addition, Lascala et al.15 evaluated the accuracy of measuring temporomandibular joint using CBCT and concluded that CBCT images have high reliability, repeatability and accuracy[21]. The advantage of CBCT for MRI is that it can perform high resolution on TMJ and provide high resolution view of bone surface [19].

3. Morphology of temporomandibular joint in children with various malocclusion

The anatomical morphology of the temporomandibular joint is related to the direction and distribution of stress in the condyle. Different types of malocclusion can lead to differences in the stress distribution of the temporomandibular joint. Therefore, the structure, morphology, position in the glenoid fossa and the morphology of the glenoid fossa are different in patients with different types of malocclusion, which have an impact on various facial types [22]. Condylar morphology and position are affected by dynamic factors such as age, gender, and functional matrix. Activities, increases or decreases in masticatory force, occlusal changes, physiological adaptation, and facial growth and development are affected [23]. The position of the condyle and the morphology of the glenoid fossa vary according to sagittal bone characteristics, and their shape and volume play an important role in the long-term stability of treatment outcomes in prosthetic, orthodontic, and orthognathic patients. Therefore, dentists should consider the morphology and positioning of the condyle during the whole treatment process. It is extremely important to understand the morphological structure of the temporomandibular joint and the position of the condyle and to restore the original position of the condyle when treating children with different sagittal malocclusion [24].

3.1. Morphology of temporomandibular joint in children with class I malocclusion

The majority of skeletal class I malocclusion children show neutral molar relationship, crowding dentition and a few crossbite. Rodrigues et al. [25] found that in the study of the temporomandibular joint in patients with skeletal Class I malocclusion, the measured value of the posterior articular space was significantly different between the left and right sides, and the mean value of the posterior articular space of the right joint was larger. Paknahad [22] et al. found that the condylar position of most class I patients was in the middle among patients with average Angle of different sagittal skeletal patterns, and some of them were posterior. However, some scholars believed that there was no significant difference between sagittal skeletal patterns and condylar position [26]. Previous studies have suggested that the condyle of patients with skeletal class I malocclusion is located in the center of the glenoid fossa, but they must have good occlusion relationship, good chewing habits, balance of oral and maxillofacial muscle motor system, and no abnormality of temporomandibular joint structure [27]. Therefore, mixed dentition is an important period for patients with skeletal Class I malocclusion to achieve stable and good occlusion through early intervention.

3.2. Morphology of temporomandibular joint in children with class II malocclusion

Skeletal class II malocclusion is characterized by mandibular retrusion, deep overbite of anterior teeth, and convex facial pattern. Although children in mixed dentition are at the peak of growth, malocclusion also affects the normal development and morphology of temporomandibular joint. Some researchers found that the condyle movement trajectory of Class II division 2 malocclusion patients was irregular [28, 29], and the condyle was unstable in the position of the joint, which was more significant than other Angle malocclusion [30]. Burke et al. [10] also found no correlation between facial morphology and the anterior and posterior position of the condyle in patients with skeletal class II malocclusion. In the sagittal direction, in patients with Class II division 1 malocclusion, the mandible cannot grow and develop normally due to the interference of the maxillary incisor. At this time, the condyle is forced to the posterior position of the glenoid fossa, and the posterior articular space is obviously smaller than that in normal occlusion [31]. Studies have shown that the growth and development of the mandibular fossa and articular tuberosity of the temporal bone are gradually stable within 2 years after initial mixed dentition and will not change with age [32]. Studies have found that after regular orthodontic treatment, the posterior and superior temporomandibular joint space of patients with Class II division 2 malocclusion increased compared with that before treatment, while the anterior joint space decreased [33], which indicated that effective orthodontic treatment was helpful to the change of condylar position [34] and achieved a stable and good state. Studies by Zhou et al. [35] found that Class II sagittal skeletal facial type may not have much relationship with the morphology and position of temporomandibular joint, but there are obvious differences in the morphology and position of temporomandibular joint in patients with different vertical skeletal facial types. Patients with high Angle have the most joint instability factors, the position of glenoid fossa is relatively higher, the depth of glenoid fossa is shallower, the proportion of posterior condyle position is larger, and the joint space is smaller. The long axis of the condyle was the shortest. Therefore, more attention should be paid to the vertical control of patients with high Angle during orthodontic treatment to maintain the health of the TMJ.

Some researchers [22] found that the condylar position of Class II division 1 patients was different from that of Class II division 2 patients. Most of Class II division 1 patients were anterior displaced, while the latter was in the position. However, other researchers have found that [26] the condylar position of class II patients is mostly anterior and partially centered. Sun Jinglu et al. found that condylar hypoplasia in patients with mandibular retrusion was not closely related to the surrounding tissues of the temporomandibular joint, such as articular discs and glenoid fossa, resulting in asymmetry of the bilateral condyles [36,37]. It can be concluded that the position of the condyle in the glenoid fossa is not static but dynamic, which can be gradually established and adaptively reconstructed with the establishment of occlusion.

3.3. Morphology of temporomandibular joint in children with class III malocclusion

Children with skeletal class III malocclusion presented with mandibular lordosis, concave facial type, and "ground covering sky" of anterior teeth. The morphological characteristics of temporomandibular joint in Class III malocclusion are gradually formed with age based on their own adaptability and compensatory ability[38]. Class III patients usually present with mandibular prognathism and maxillary retrusion, overdevelopment of posterior height, and relatively long condyle. After measuring and analyzing the skeletal structure of the temporomandibular joint in adolescents, some researchers concluded that the condyles of patients with high Angle in skeletal class III were more flat and wider than those in skeletal Class I [10, 39]. Yuan Fanglian et al. [40] also came to a similar conclusion by comparing the CBCT of the temporomandibular joint of young patients with individual normal occlusion and skeletal class III malocclusion, that is, for individual normal occlusion, the condyle and glenoid fossa of young patients with high-angle skeletal class III malocclusion tend to be flat and wide. Other researchers have found that [28] the condyles of class III patients are mostly in the posterior position. Cohlmia[10] et al. found that condylar positions were closer in patients with skeletal Class III malocclusion than in those with skeletal Class I malocclusion, but there was no difference between skeletal Class I and Class II malocclusion. The results of foreign studies have shown that the condylar width, condylar height and fossa height of the class III group are higher than those of the Class II group, and the condyles of the skeletal class III patients are smaller and better positioned than those of the skeletal Class II patients [22, 24].

4. Conclusion of study

Mixed dentition is a critical period for the establishment of physiological occlusion. It is very important to learn and understand the morphological structure of the temporomandibular joint (TMJ) in early treatment and study of patients with malocclusion in mixed dentition. If we do not pay attention to the TMJ, we will miss the best early treatment opportunity in mixed dentition, which will not only increase the difficulty of treatment in permanent dentition, but also may cause temporomandibular joint disease. Therefore, it is very important to analyze the morphological structure of TMJ in patients with malocclusion before early treatment in mixed dentition, such as CBCT, and to provide the best prevention and treatment measures.

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