Medicine and Drugs International Research Journal
ISSN: 2997-6642 |
Volume 11 Issue 1, January-March, 2023
Journal Homepage: https://ethanpub.online/Journals/index.php/E28
Official Journal of Ethan Publication

RADIOGRAPHIC ASSESSMENT OF OVER-ERUPTED THIRD MOLARS AND THEIR IMPACT ON TEMPOROMANDIBULAR JOINT HEALTH

Xiaojie Wang, Qiang Zhang and Meiying Liu
Oncological Department of Oral and Maxillofacial Surgery, the First Affiliated Hospital of Xinjiang Medical University, School/Hospital of Stomatology Xinjiang Medical University, Urumqi, Xinjiang Uygur Autonomous Region, 830054, China

Abstract:
The evolution of human beings has led to significant changes in the third molars (wisdom teeth), characterized by congenital absence, impaction, abnormal tooth positioning, and occlusal disturbances. While some studies have suggested a potential link between the elongation of third molars and the absence of opposing teeth, systematic research on this topic is lacking. Furthermore, the relationship between abnormal occlusal features of third molars and temporomandibular disorders (e.g., anterior disc displacement with reduction, osteoarthritis) remains to be explored. Notably, there appears to be a substantial correlation between morphological alterations in the temporomandibular joint (TMJ) and the elongation of third molars. This mechanism may involve condyle displacement due to a disorder, subsequently leading to a disruption in the disc-condyle relationship.

Keywords: third molars, wisdom teeth, congenital absence, impaction, occlusal disorder, temporomandibular disorders, temporomandibular joint, condyle displacement.

1. Introduction

With the evolution of human beings, the third molar (wisdom teeth) has shown an obvious trend of degradation, which is manifested as congenital absence, impaction, abnormal tooth position, and occlusal disorder. Some scholars have pointed out that there is a certain relationship between the elongations of third molars due to the absence of opposing teeth. However, the results of systematic studies on this aspect have not been reported. The relationship between abnormal occlusal characteristics of third molars and temporomandibular disorders (such as anterior disc displacement with reduction, osteoarthritis, etc.) remains to be studied. There is a significant relationship between the morphological changes of the TMJ and the elongation of the third molar. The main mechanism may be caused by the displacement of the condyle caused by disorder, followed by the discoordination of the disc-condyle relationship [1-4].

2. Malocclusion caused by third molar elongation

The third molar extended to contact the opposing second molar, producing an abnormal bite force. At the same time, the impact force will also be generated on the distal surface of the adjacent teeth, which will affect the accurate occlusion position of the adjacent teeth [5]. Third molars with elongation often have posterior arch interference, especially strong occlusal interference during forward movement [6]. Due to the adaptive compensatory effect of the body, malocclusion has little effect on the stomatognathic system in the short term. Once it exceeds the compensatory stage, muscle and temporomandibular joint damage will occur [7-8]. Therefore, occlusal interference should be detected and removed as soon as possible in clinical practice.

The study by Guo S et al. found that mandibular third molar elongation may have an effect on the precise occlusal contact site of adjacent molars by providing the effect of mesial orientation on its distal surface. This effect can be seen as a specific tooth wear surface, which develops over time. Because of the formation of these facets, the original influence of the elongated third molar remains unchanged even if it is extracted. According to this view, the simple extraction of the third molar at a later stage may not be sufficient to correct the masticatory pattern formed under its influence, as the formed wear face will continue to affect the masticatory pattern. A more complete correction of the worn dentition may be necessary. The excessive elongation of the mandibular third molar has some effect on the chewing pattern, but this effect is limited in terms of symptoms [9].

Wang Meiqing et al. studied the chewing trajectory of patients with third molar elongation and confirmed that the occlusal impact force required by patients with third molar elongation was larger than that of patients with normal occlusion when chewing the same food. The elongation and ectopic eruption of the third molar can lead to the noncontact between the upper and lower cusps during ICP, and the stability of the median occlusion and the balance of lateral he movement are decreased. When the function of TMJ reconstruction needs to exceed the adaptive reconstruction ability of the tissue itself, it becomes the biological basis for the occurrence of TMD [10]. Wang Jingjie and Zhang Min et al. found that the elongation of the third molar can lead to significant changes in the stress characteristics of the root apex of the mandibular teeth. Such changes may be transmitted to the temporomandibular joint through the mandible, causing significant changes in its stress and causing a series of symptoms, but the relevant problems need to be further explored [11].

3. Imaging studies

3.1 CBCT

CBCT is a three-dimensional imaging diagnostic equipment commonly used in oral and maxillofacial examination in the world in recent years. It has high resolution and definition, and can accurately diagnose maxillofacial abnormalities [12]. The examination time of CBCT is short and the radiation dose is only 1/400 of that of high-resolution CT. Through the use of computer software, the two-dimensional data obtained from the projection can be reconstructed to obtain the condylar position and bone changes from multi-angles and multi-layers such as axial, sagittal and coronal views, which can reflect the threedimensional structure of mandible more realistically and comprehensively. It shows bony structure [13], which makes up for the deficiency of X-ray film. At the same time, this diagnostic method has high spatial resolution, high imaging quality, low examination cost, less radiation, less negative impact on patients, and higher patient acceptance. It is widely used in the examination of oral diseases.

CBCT can clearly depict the bone structure of the TMJ without overlapping with the skull. CBCT has specific morphological manifestations, which is helpful for the accurate diagnosis of TMJ bone lesions, including arthropathy, osteoarthritis, degenerative joint disease, etc [14].

3.2 MRI

MRI is the best imaging technique for the evaluation of TMD patients. It has good soft and hard tissue contrast, and can provide the best soft tissue visualization of temporomandibular joint and masticatory muscle. It has good spatial resolution and contrast resolution, and combined with the high signal-to-noise ratio provided by the biphasic array surface coil and high field strength at 3T, it can obtain good evaluation of soft tissue, cortical bone and bone marrow. MRI of TMJ can evaluate disc displacement, effusion, synovitis, joint cortex, bone marrow, masticatory muscles, adjacent parotid gland tissue and external auditory canal. However, the accuracy of MRI is highly dependent on the standard of equipment and the experience of the observer. In middleaged and elderly patients, when the underlying cause is more likely to be arthritis than disc displacement, multi-slice spiral CT may be the first choice for evaluating TMD [15-16].

4. Traditional joint imaging studies

Previous studies on TMJ morphology were often based on panoramic radiographs or CBCT and other imaging data to measure two-dimensional indicators such as temporomandibular joint space, anterior posterior diameter, inner and outer diameter, cross-sectional area, and height of condyle to analyze the changes of TMJ morphology, and there was a lack of three-dimensional comparative studies [17-20].

The changes in the temporomandibular joint are three-dimensional, with complex changes in each direction. Therefore, compared with three-dimensional technology, which can locate and quantify the absorption mode of TMJ, only two-dimensional (2D) images cannot comprehensively and accurately observe the actual changes of TMJ, which has certain limitations.

5. Three-dimensional reconstruction technology

In recent years, scholars in various medical fields have begun to explore and study the joints of the human body through three-dimensional reconstruction technology. Three-dimensional reconstruction of medical images refers to the use of scientific computing visualization technology to convert twodimensional image data obtained from medical imaging equipment into three-dimensional data, so as to show the three-dimensional morphology of human tissues and organs and conduct qualitative and quantitative analysis [21].

Mimics is a digital 3D interactive medical image control system developed by Belgium Materialise Company. It is a highly integrated, simple and easy-to-use 3D image generation, editing and processing software [22]. Through the input of various two-dimensional scanning data (CT, MRI images), the accurate three-dimensional digital model is reconstructed, and the general computer aided design (CAD), finite element analysis (FEM), and finite element analysis (FDA) are used. FEA), rapid proto-typing (RP) and other data format output, and large-scale data conversion processing on personal computers.

At present, CT, MRI and other tomography techniques are widely used in clinical diagnosis and treatment, but two-dimensional tomography images express the anatomical information of a certain section. Most doctors rely on experience to estimate the size and shape of the lesion from multiple twodimensional images, which brings difficulties to treatment. Although the vast majority of current CT and MRI equipment have matching 3D reconstruction software, it can only be used under specific equipment. The surgeons in the imaging department can only copy the reconstructed three-dimensional images into two-dimensional images according to their ideas of several parts and angles and submit them to the clinicians. However, the 3D model reconstructed by Mimics software on the ordinary computer can be dynamically rotated and observed, arbitrarily cut to show the internal anatomical structure, or edited and modified [23], so that clinicians can conduct more in-depth and detailed localization, qualitative and quantitative analysis of the lesion.

Liu Qi [25], Feng Gang [26], Liu Jianlin[29] et al. have studied the volume, surface area and other threedimensional indexes of TMJ to analyze the difference of bilateral condyle morphology based on CBCT data through three-dimensional reconstruction, and have achieved relatively ideal research results
[27, 28, 30, 31].

Kyungjae Han [32]et al. used the data obtained from 3D cone-beam computed tomography (3D CBCT) to carry out computer reconstruction and new 3D stacking method to evaluate patients with temporomandibular joint (TMJ) osteoarthritis. Condylar changes were evaluated at three time points over a 5-8 year time range: initial (T0), intermediate (T1), and final (T2) to observe condylar changes over time in long-term TMJ osteoarthritis. Absorption was found to occur primarily in the upper region, with decreasing rates in the posterior, lateral, and anterior regions. Medial position absorption was greater than lateral position in all regions, and both absorption and reconstruction were observed in condyles with TMJ osteoarthritis. The pattern of absorption and reconstruction depends on the individual condyle and its location.

6. Three-dimensional finite element analysis

Traditional biomechanical methods are traumatic, unrepeatable and difficult to compare different force distributions. Finite element analysis (FEA) is a numerical method for solving complex structural mechanics problems. In recent years, finite element analysis has been widely used in medical biomechanics research, especially in orthopedic instruments under various loading conditions. The complex structure of temporomandibular joint limits the biomechanical study of temporomandibular joint. Due to imaging difficulties, studies on the finite element analysis of temporomandibular joint are still scarce. In Tanne's study [33], three-dimensional finite element models of mandible (including cortical bone, cancellous bone, articular cartilage and articular disk) were established by slicing skull specimens. The articular disk was simulated as a 2mm thick tissue covering the surface of the bone process to investigate the stress conduction mode of cranial and maxillary system under stress. The mandible model was established by CT scanning on the basis of normal mandible specimens. The stress, strain, deformation and condylar response of jaw bone were analyzed systematically with this model.

Although some progress has been made in the modeling of the temporomandibular joint model, in the case of the abnormal intra-articular structure, the model cannot perform accurate soft tissue reconstruction, and the influence of the articular disk is ignored. In addition, previous studies rarely considered the changes of temporomandibular joint friction coefficient in TMD patients.

Linfeng Lai[34] et al. collected CT and MRI images of TMD-free volunteers and TMD patients. Subsequently, a 3D finite element model including the maxilla, intervertebral disc and mandible was established using 3D data registration technology. The influence of friction coefficient change on disc displacement was explored. A three-dimensional finite element model including maxilla, fossa, mandible, whole dentition and temporomandibular disc displacement was established. At any Angle, the mesh division is uniform and smooth, and the mesh coordination is good. Such a model can directly show the spatial relationship between the articular disc, mandible, fossa and other structures. It is suggested that the mechanical environment of TMJ plays an important role in the normal physiological function, formation and prognosis of TMDs.

Ziling Zhou [35] et al. used CT, conical beam CT (CBCT), MRI and 3D scanner to establish a threedimensional finite element model of the oral and maxillary system to accurately reflect the morphological characteristics of the occlusal surface. Based on individual occlusal contact data obtained by the patient during maximum voluntary occlusion (MVC), the contact area is marked on the occlusal surface of the tooth. Two occlusal contact conditions were constructed, including normal occlusal and unilateral posterior inverted occlusal (UPC). The model was fixed in the contact area to simulate MVC conditions to analyze the stress distribution in TMJ. The results show that the stress distribution of TMJ in the 3D finite element model of human occlusal contact is highly sensitive to the change of occlusal contact. Abnormal occlusal contact caused by UPC may result in stress concentration of TMJ on the reverse occlusal side.

You-lai Lin[36], in order to compare and analyze the stress distribution of various structures of temporomandibular joint in the case of individual posterior tooth reverse occlusion and normal occlusion, in order to provide evidence for the necessity of individual posterior tooth reverse occlusion orthodontic treatment from the perspective of biomechanics, Using the established geometric model of normal occlusal TMJ, they established three-dimensional finite element models of individual back teeth with reverse occlusal and normal occlusal TMJ. The same bite force and boundary conditions were applied to the two models to simulate the working condition loading during the interlacing of the tooth tip, and the TMJ stress distribution of individual back teeth in reverse occlusion and normal occlusion was analyzed and compared. In their experimental surface, the stress distribution in the bilateral TMJ of the back occlusion of individual teeth was uneven, and the stress value increased compared with that of the normal occlusion, which could cause the overload stress and local stress concentration of the TMJ. Therefore, timely and active treatment should be conducted in clinical practice for the back occlusion of individual teeth.

7. Summary

With the continuous progress of society, the allocation of medical resources tends to be more and more balanced. CT, MRI and other equipment have been widely used in primary hospitals. Convenient and practical Mimics software combined with medical imaging resources with rich access has broad space for development. The application of Mimics software three-dimensional reconstruction in clinical orthopedic diseases provides a new idea for solving sports injury, functional rehabilitation and prosthesis implantation. Therefore, in the future, three-dimensional imaging tools can be combined to analyze and study the temporomandibular joint morphology of patients with third molar elongation in a more novel and multifaceted way.

References

Tiwari A, Lata J, Mishra M. Influence of the impacted mandibular third molars on fractures of the mandibular angle and condyle – A prospective clinical study[J]. Journal of Oral Biology & Craniofacial Research, 2016:227-230.

De Sousa AS, Neto JV, Normando D. The prediction of impacted versus spontaneously erupted mandibular third molars. [J]. Prog Orthod, 1970, 1: 29.

Moreira PEO, Normando D, Pinheiro LR, et al. Prognosis for the impacted lower third molars: Panoramic reconstruction versus tomographic images. [J]. Oral Surg Oral Med Oral Pathol Oral Radiol, 2020, 6: 625-631.

Koide D, Yamada K, Yamaguchi A, et al. Morphological changes in the temporomandibular joint after orthodontictreatment for Angle Class II malocclusion [J]. Cranio, 2018, 36(1): 35 - 43.

Bozhkova T P. The T-SCAN system in evaluating occlusal contacts [J]. Folia Medica (Plovdiv), 2016, 58(2): 122-30.

Guo S X, Li B Y, Qi K, et al. Association between contact from an over erupted third molar and bilaterally redistributed electromyographic activity of the jaw closing muscles [J]. J Oral Faclal Pain Headache, 2018, 32(4): 358- 66.

Fernández R A R, Pereira Y C L, Iyomasa D M, et al. Metabolic and vascular pattern in medial pterygoid muscle is altered by chronic stress in an animal model of hypodontia [J]. Physiol Behav, 2018, 185(2018): 70–8.

Su Yiling, Hou Aibing, Wang Nan. Association between third molar protrusion and temporomandibular disorders [J]. Journal of Anhui Medical University, 2021, 56(10): 1607-1611.

Guo S, Li B, Qi K, et al. Interferential effect of the over-erupted third molar on chewing movement. [J]. Arch Oral Biol, 2017: 147-152.

Wang Meiqing. Modern Science [M]. Beijing: People's Medical Publishing House, 2006, 18-150. [11] Wang Jingjie, Zhang Min, Wang Meiqing, Zhang Junhua, Zhang Yuan. A photoelastic experimental study on the influence of the elongation of the third molar on the stress distribution of the root apex of the mandibular teeth [J]. J Endodontics and Periodontology, 2002(05): 261-265+288.

Zeng D L, Liu Y, Zhang Z G, et al. Application of arthrography and cone-beam CT imaging in the diagnosis of temporomandibular disorders [J]. Chin J Stomatology, 2020, 55 (9): 634-638.

Lei Jie, Qin Sisi, Fu Kaiyuan. Evaluation of condylar bone stability in patients with severe temporomandibular joint osteoarthrosis by cone beam CT [J]. Chin J Orthodontics, 2017, 24 (4): 212216.

Larheim T, Abrahamsson A, Kristensen M, Arvidsson L. Temporomandibular joint diagnostics using CBCT. Dentomaxillofac Radiol 2015; 44: 20140235.

Yilmaz D, Kamburoglu K. Comparison of the effectiveness of high reso-lution ultrasound with MRI in patients with temporomandibular joint disorders. Dentomaxillofac Radiol 2019; 48: 20180349. [16] Tomas X, Pomes J, Berenguer J, et al. MR imaging of temporomandib-ular joint dysfunction: A pictorial review. Radiographics 2006; 26: 765-781.

Paknahad M, Shahidi S, Akhlaghian M, et al. Is Mandibular Fossa Morphology and Articular Eminence Inclination Associated with Temporomandibular Dysfunction? [J]. Journal of Dentistry, 2016, 17(2): 134-141.

Yao Xuedong, Fan Songqing, An Gao. Measurement and analysis of the bone structure of temporomandibular joint [J]. Chin J Stomatology, 2011, 27 (6): 801-804.

Wang Ruiyong, Ma Xuchen, Zhang Wanlin, et al. Measurement and analysis of temporomandibular joint space by cone-beam computed tomography in healthy adults [J]. Journal of Peking University, 2007, 39(5): 503-506.

Li Y F, Guo X Q, Chen Y, et al. Comparative measurement of bilateral temporomandibular joint using CBCT [J]. Chin J Med Physics, 2014, 31(2): 4810-4813.

Tian Jie, Bao Shanglian, Zhou Mingquan. Medical image processing and analysis [M]. Beijing: Publishing House of Electronics Industry, 2003:117-151. (In Chinese)

Solaro P, Pierangeli E, Pizzoni C, et al. From computerized tomographydata processing to rapid manufacturing of custom-made prostheses forcranioplasty case report [J]. Journal of Neurosur.

Gu Zexu, Chen Xuepeng, Gao Feng. J Stomatology, 2008, 24 (1): 103-106.gical Sciences, 2008, 52: 55-57.

Cao L Y. CBCT study of condylar and maxillofacial symmetry in patients with unilateral posterior crossbite [D]. Chongqing Medical University, 2012.

Liu Qi, Wei Xiaoer, Zou Derong, Yu Lufeng. Application of Mimics software in the measurement of condylar volume and surface area [J]. Stomatology Research, 2017, 33(04): 404-408.

Feng Gang, Zhou Jianping, Wu Yang, Zhou Xiaofeng, Dai Hongwei.. Measurement of mandibular condyle volume and surface area in Class Ⅰ malocclusion patients by cone-beam CT [J]. Chinese Journal of Tissue Engineering Research and Clinical Rehabilitation, 2011, 15(43): 8014-8018.

David Kilian, Philipp Sembdner, Henriette Bretschneider, Tilman Ahlfeld, Lydia Mika, J? rg Lützner, Stefan Holtzhausen, Anja Lode, Ralph Stelzer, Michael Gelinsky. 3D printing of patient-specific implants for osteochondral defects: workflow for an MRI-guided zonal design [J]. Bio-Design and Manufacturing, 2021, 4(04): 818-832.

Fan Jihong. System engineering and Examples from Mimics Modeling to Marc Finite Element Analysis [D]. Southern Medical University, 2010.

Liu Jianlin, Fu Chongjian. A preliminary study on three-dimensional dynamic measurement of temporomandibular joint [J]. Chinese Journal of Geriatrics and Stomatology, 2016, 14(3): 171-176. [30] Krisjane Z, Urtane I, Krumina G, et al. Condylar and mandibular morphological criteria in the 2D and 3D MSCT imaging for patients with Class II division 1 subdivision malocclusion. [J]. Stomatologija, 2021, 3: 67-71.

Noh KJ, Baik HS, Han SS, et al. Differences in mandibular condyle and glenoid fossa morphology in relation to vertical and sagittal skeletal patterns: A cone-beam computed tomography study. [J]. Korean J Orthod, 1970, 2: 126-134.

Han K, Kim MC, Kim YJ, Song Y, Tae I, Ryu JJ, Lee DY, Jung SK. A long-term longitudinal study of the osteoarthritic changes to the temporomandibular joint evaluated using a novel three-dimensional superimposition method. Sci Rep. 2021 Apr 30; 11(1):9389. doi: 10.1038/s41598-021-88940-y. PMID: 33931699; PMCID: PMC8087707.

Jingxu L I, Runguo W U, Rong L I, et al. The influence of the presence and impacted state of mandibular third molar on the incidence of mandibular condyle fracture[J]. Journal of Practical Stomatology, 2013, 29(2):253-256.

Lai L, Huang C, Zhou F, Xia F, Xiong G. Finite elements analysis of the temporomandibular joint disc in patients with intra-articular disorders. BMC Oral Health. 2020 Mar 30; 20(1):93. doi: 10.1186/s12903-020-01074-x. PMID: 32228551; PMCID: PMC7106847.

Zhou Z, Zhang Y, Shi L, Yang L, Liu H, Ding Y. [A three-dimensional finite element study on the temporomandibular joint based on individual occlusal contact]. Chinese Journal of Stomatology. 2015 May; 50(5): 302-6. Chinese. PMID: 26082053.

Lin YL, Liu YH, Wang DM, Xu JW. [Three-dimensional finite element analysis on the effect of posterior cross-bite of individual teeth on temporomandibular joint]. Chinese Journal of Stomatology. 2013 Feb; 48(2): 86-90. Chinese. PMID: 23714060.