Clinical and Basic Research on Mechanical Problems in Orthodontics

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Abstract: Mechanical problems in orthodontics play an important role in the application and implementation of clinical treatment. Combined with clinical diagnosis, orthodontic treatment is becoming more and more mature, which can meet the different needs of different oral patients. With the deepening of basic research, the mechanism of occurrence and correction of oral malocclusion has become the current research focus in the oral field. The mechanical relationship in orthodontics can not only be used for treatment, but also provide scientific basis for the formation of right and wrong deformities. For orthodontics, mechanics will play a greater role in clinical examination, diagnosis and treatment.

1. Introduction

The reason why the role of mechanics in orthodontics has been widely concerned is that its means are more and more applied to the orthodontic process, and with the continuous improvement of the application means, it will enter a safer, more effective and faster era of orthodontic mechanics.

2. Summary of Clinical and Basic Research on Mechanical Problems in Orthodontics

With the continuous improvement of people’s aesthetic requirements and quality of life, the correction of wrong deformities is more urgent, which not only provides opportunities and challenges for the development of orthodontics, but also brings new challenges to orthodontists. The Orthodontics Committee of the Chinese Stomatological Association officially joined the World Orthodontics Alliance in 2010, which indicates that the orthodontics in China is entering a new stage. We need to develop new orthodontic diagnosis and treatment technologies and concepts to meet the living needs of more people[1].

2.1 Mechanics Related Concepts in Orthodontics

The first is force. The mechanical force in orthodontics mainly includes force and reaction force. The existence of force is inseparable from the orthodontic process, and this force presents different force values at different angles and positions, and many forces are in opposite directions. In the process of orthodontic correction, it is necessary to consider the size of the force, and make good use of the role of the force in different positions, especially the existence of reaction force.

The second is torque and couple. Torque is mainly expressed as the product of force and force arm when the object rotates. A couple is two forces acting on an object, which are equal in size, but often in opposite directions, and are carried out on the same straight line. The two forces are also parallel to each other. The force system thus formed is called a couple. Where there is a couple, the force couple distance is equal to the result of multiplying one of the forces by the couple arm.

The third is the impedance center. In orthodontics, impedance is an important component. The impedance center of an object in free space is the center of mass of the object itself. In the gravity field, it is the center of gravity, which is a mechanical concept related to orthodontics.

The fourth is the center of rotation. The so-called center of rotation refers to the center around which the object rotates under the action of external forces.

2.2 Main Role of Mechanics in Orthodontics

It mainly includes the following aspects:

First, force value, which is divided into gravity, medium force and light force. Gravity: It is the function of the gravity line of the earth. For example, the head and neck are the extraoral traction force of the anchorage, in which the force value should be more than 350g. In clinical practice, it is often used as an orthopedic force to guide the normal growth of the maxillofacial region.

Medium force: It is consistent with gravity in action, but its force value is 60-350g. The force value of light force is below 60g. The second is translation. The so-called translation is that it is often more difficult to use the arch contraction ratio than to expand the arch, so it is generally not recommended to contract the arch with the whole mouth, even if the patient's mouth is symmetrical. The translation means that the range of single quadrant pantograph retraction should be based on the actual situation but not more than 2 teeth without traction. The third is to press down or stretch, mainly in the middle locking jaw correction, because the angle caused by the front teeth cannot be greatly depressed, so the method of pressing down and stretching can be effectively reduced by half or a small amount. In the process of lowering, we should master the principle of "try to do as much as possible, do not put it at home; try to lower it by sections". At the same time, place accessories when pressing down 7. Specifically, clinically, it is necessary to add accessories to the adjacent teeth. If no accessories are added to the depressed teeth, the force will be uneven, and there must be a mutual complete anchorage to achieve this. Fourth, torsion. During the orthodontic process, it is feasible to realize the extension of periodontal ligament by torsion in sports mechanics. Generally, the periodontal ligament will not be cut off for reconstruction. In clinical practice, traction assisted torsion is recommended for premolars> 40°[2].

2.3 Clinical Application of Mechanics in Orthodontics

First, in the process of orthodontics, if the jaw pad is placed at the end of the appliance, it should be kept 3mm away from the edge. This can ensure an angle of the jaw pad and meet the needs of mechanics.

Second, the tooth movement difficulties during the orthodontic process are related to mechanical factors, including the mechanical reasons caused by alveolar bone defects, such as bone windowing, bone cracking, etc. In addition, maxillary sinus, gingiva, root adhesion, bone island and friction are all related to mechanics. Third, the correction force and retention force used in the orthodontic process are the components of the anchorage system. Fourth, the effect of the invisible appliance on the teeth is reflected in the change of the force value. For example, the force with rapidly decreasing force value is not an intermittent force, but the force equivalent to the force of the tooth recurrence after reaching the corresponding position, which also makes the invisible orthodontics far better than the fixed effect in controlling the torque of the front teeth, reflecting the value of mechanics.

Fifth, the vertical bite force is particularly important in the orthodontic process, which is reflected in the change of resistance torque. For example, in the case of tooth extraction patients, they need to take the appliance to eat, so as to make the earth attraction corresponding to tooth extraction. The tooth root moves best in the cancellous bone, so once the bone window is opened and the bone cracks, the periodontal ligament is broken, and the periosteum is gone, it is not easy to repair.

3. Clinical Orthodontic Analysis of Orthodontics Mechanics

According to the clinical situation, the application of mechanics has been fully realized in the movement. There are five common tooth movements, which are closely related to the basic mechanical principles of orthodontic mechanics. Although there are five types of tooth movements in the orthodontic treatment, and these five types sometimes interact, such as the relationship between tilt movement and vertical movement, the overall movement and rotation movement, and root control movement, which all reflect different mechanical relationships. Although it looks complicated, it actually represents only two basic mechanical methods or viewpoints, namely

translation and rotation, which depend on the position relationship between the impedance center and the rotation center during the orthodontic process. From the perspective of translation, when the external force line passes through the impedance center of the tooth, it will cause the tooth to move, and the rotation center is still very far from the impedance center. Rotation proves that when a couple acts in the opposite direction at the corresponding equidistance with the impedance center as the center, its teeth will change, which will cause the teeth to rotate. At this time, the rotation center is at the impedance center.

From the analysis of the orthodontic process, it can be concluded that any object has its own center of mass, or center of gravity. This is fully illustrated by the mechanical relationship during the orthodontic process. For example, if the free body has no other resistance, its movement depends on the relationship between the action line of the external force and the center of gravity. The tooth is relatively complex, in addition to its own quality, the tooth also connects the periodontal fiber and the alveolar. It can be seen from the process of tooth movement that the tooth will be subject to the resistance of the above two. Therefore, the resistance of different parts of the root surface is inconsistent, especially in different types of tooth movement, there are different forces and reactions, and the reaction and effect of the supporting tissues are also different. From the point of view of the tooth impedance center and the geometric center of the root, it is basically consistent, and the impedance center of a single tooth is near the alveolar ridge on the tooth long axis, which is about 1/2 to 1/3 of the root length. The impedance center of multiple teeth is 1 mm~2 mm from the root bifurcation to the root tip. Its position varies with the length of root and has no direct relationship with the force. Therefore, the formula for calculating the location of the impedance center is expressed as: Y=3/5h (h is the root length). Or take the long axis of the root of a single tooth as the ordinate for classification, the location of the impedance center Y is usually 2/5 of the root length from the top of the alveolar ridge, and 3/5 from the root tip, which fully indicates the changing relationship between the tooth center and the center of gravity. The rotation center of the tooth is the change of the surface according to the relatively stationary point during the tooth movement. The rotation center of the tooth changes with the action point of the orthodontic force during the orthodontic process, and also has a relationship with the action mode.

In addition, from the perspective of tooth force, because the analysis of orthodontic force system cannot be comprehensive and accurate, it often leads to irreversible safety hazards in the orthodontic treatment process, making patients have side effects. These side effects become a label of orthodontic success and failure. Orthodontic mechanics is a prerequisite for success, because the basic mathematical model of orthodontics can meet the incomplete and imprecise problems through digital model design and shaping, better play and use the positive role of multi-dimensional digitization in orthodontics. For instance, the practice and application of three-dimensional finite element analysis is to realize the support of various mathematics and experiments based on the simplification and assumption of mathematical formulas, and to verify the results.

4. Research Progress in Mechanical Basis of Orthodontics

With the rapid development of computer technology based on digitalization and informatization, a large number of “delicate tasks” that need time to complete have been omitted in the orthodontic process, and doctors can spend a lot of time to determine the effect of observation and fine polishing. For example, the application of CAD/CAM technology in bending arch wire can shorten the course of treatment, improve the work efficiency and treatment accuracy, and at the same time, make the more complex bending process of arch wire programmed and standardized, and can achieve a relatively small angle and torsion of 1°, so as to achieve the maximum control of teeth. In addition, transparent all polymer hot formed arch wire composed of self-reinforced polymer polyphenylene is also a new material. This new type of polymer can meet the immediate mechanical function, and promote the full deployment of its dense molecular structure, so that the arch wire has high extensibility and resilience. In addition, it can also provide some aesthetic functions of the arch wire for beauty lovers, and the color can be replaced at will, making it possible for patients to change the color of their teeth.

At present, a new intelligent bracket model that can measure the force and torque is also beginning to be used in clinical practice. In order to achieve computer digital treatment, improve the precision of fine force, and better complete the mechanical feedback, the model implanted the microchip of the micro electromechanical sensing system into the patient's bracket, and is equipped with a new simulation device. In addition, the orthodontic simulator is also in the development stage, which consists of two parts. The upper part is simulated teeth, and the lower part is a sensor of three-dimensional force. It can reproduce specific malocclusion by collecting and analyzing data, so as to analyze the three-dimensional mechanical information of the teeth in the dental arch under the action of orthodontic force.

5. Conclusion

Due to the development of orthodontic mechanics, patients have more opportunities to choose, and this excellent model of orthodontic mechanics will be reflected in all aspects of the clinical orthodontics, so as to achieve a comprehensive and fine means of examination, diagnosis and treatment, so that patients can get a better diagnosis and treatment experience.

References

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