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Mini Review Article

Robotic Wire Bending in Orthodontics

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ABSTRACT

Malocclusion is the third largest oral disease in the world. At present, the most effective treatment method for malocclusion is the fixed orthodontic technique. Archwire bending is one of the key components in orthodontic treatment. However, it is a very difficult work due to the high stiffness and super elasticity of orthodontic wire. The traditional way of acquiring the formed archwire curve is based on manual operation, which will randomly bring numerous errors caused by human factors. In clinics, customized archwires are demanded for lingual orthodontic treatment. Traditionally, these archwires could only be bent by experienced orthodontists manually. This pattern requires a specialized skill training, precision and occupies long chairside time, but still cannot ensure the accuracy of appliances. So what are the recent advances to overcome the shortcomings of archwire bending? Robotic archwire bending can overcome the shortcomings of manual bending by increasing the treatment accuracy, efficacy and efficiency, also decreasing the treatment time and patient discomfort thus improving the orthodontic treatment in general.

Keywords: Archwire; Robotic; Orthodontic treatment; Malocclusion

INTRODUCTION

In human growth and development process, malocclusion is a common kind of mouth disease due to genetic and environmental factors. It is always associated with teeth malposition and abnormal arrangement of the dental arch [1]. It not only affects appearance or the growth of maxillofacial but also affect the function of mastication and pronunciation and may easily cause dental caries, periodontitis, and other oral diseases. With the development of the society, more and more people began to pay attention to dental health and aesthetics. At present, the fixed orthodontic technique is the most effective manner to treat malocclusion. In this therapy, the deformed teeth are corrected by restoring the force that is generated by the deformation of the archwire. So the archwire bending process plays a major role in orthodontic treatment [2].

In the process of manual archwire bending, the quality of archwire bending depends on the doctor's archwire bending skill. And the treatment of different cases needs archwires with different parameters. In the bending process, archwire needs to be bent many times to realize the best therapeutic effect. Therefore, the bending efficiency is low, and the fatigue damage is more easily to produce on the archwire [3]. The application of robot technology to the bending of orthodontic archwires can effectively overcome these shortcomings.

A robot is a machine capable of carrying out a complex series of actions automatically, especially one programmable by a computer. These days, robots are utilized in modern field, fabricating measure, clinical fields, and military purposes. Dentistry has seen colossal improvements and movements from the standard techniques to the modernized world that has enlarged the degree of dental treatment and frameworks [4]. Advancements in three-dimensional imaging and assembling measures have made the customization of orthodontic apparatuses to improve treatment effectiveness conceivable. Advances in innovation have yielded two patient-explicit items that use computers to make an intelligent treatment plan, and afterward make a customized appliance, such as the insignia system.

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The bending art system

It is the first ever developed CAD/CAM system for the fabrication of customised orthodontic arch wires. Professor Helge Fischer-Brandies invented this in 1984 and his co-worker, together with an engineering company developed this hardware and software. The first prototype of BAS was manufactured. It is used for fabrication of both labial and lingual orthodontic wires [5].

MOTOMAN UP6

A different type of a robot used in orthodontic archwire bending that is based on MOTOMAN UP6. It is composed of a computer and a twisting devices for the archwire. As the archwire's shape is complex the robot end must be flexible when the robot is bending the archwire. And the MOTOMAN UP6 robot which has six freedoms can fulfil the request of flexibility that the archwire bending.

LAMDA system

LAMDA system or a lingual archwire manufacturing and design aid is a system for rapid and exact bending of the archwire. Developed by Alfredo Gilbert, the system uses a robot that can bend the archwire in two planes which restricts the applications of the system [6].

Cartesian type archwire bending robot

This system of archwire bending uses a robot that has multiple components. The bending procedure is examined and the structure of the archwire is designed with the included software. This cartesian orthodontic archwire bending robot comprises of the support mechanism, archwire posture control mechanism, archwire rotating mechanism, archwire support block, archwire rotary die, archwire fixed die, archwire rotary die posture control mechanism, blocking arcwire mechanism [7]. The cartesian orthodontic archwire bending robot can bend larger angle, and mainly make use of screw nut movement platform and stepper motor, non-standard parts are relatively small. It is easy to mass product and control. However, its end actuator structure is single, so it is difficult to meet the bending requirements of the individual archwire. Following figure shows an example of an archwire that is bent using the cartesian framework.

Suresmile

Suresmile is an all-digital system which uses new 3-D imaging the and computer techniques for diagnostics and treatment planning and uses robotics to customize fixed orthodontic appliances. The procedure starts with the orthodontists uses digital images of a patient's mouth and teeth using either a white light scanner or Cone Beam Computed Tomography (CBCT). Afterwards the technician adjusts the teeth to ideal position. The information is then sent to a computer were little adjustments take place. The dentist inters the data that has the location and the tension for the brackets and the wires to the system and sends it to suresmile head office. Now the use of the robots start, the archwire is held by two mechanical grasping pliers which beds the wire into the desirable shape [8].

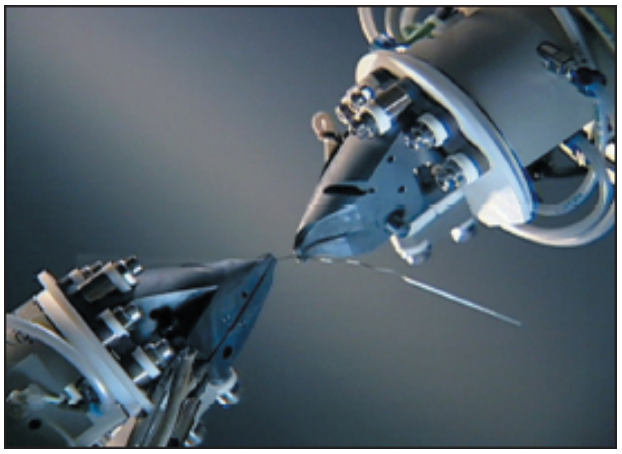

Figure 1: Bending orthodontic archwires into particular shape.

Orthodontics archwire bending robot: A robotic bending tool has apparatus for automatically bending orthodontic archwires into a particular shape, which is shown in Figure 1. The bending apparatus is known as SureSmile archwire bending robot. The bending apparatus comprises a robot mounted to a base or table support surface. A first gripping tool has a structure for holding the archwire or other medical device and is either be fixed with respect to the base or may be incorporated into a moveable arm. The second gripping tool is mounted to the end of a moveable six-axis robot arm having a proximal portion also mounted to the base and a distal end that can move relative to the fixed gripping tool about three translational and three rotational axes. Preferably, the gripping tools incorporate force sensors which are used to determine overbends needed to get the desired final shape of the archwire and may also include a resistive heating system in which current flows through the wire while the wire is held in a bent condition to heat the wire and thereby retain the bent shape of the wire [9].

DRAWBACKS

The complexity of the oral cavity and the bodily traits of the archwire material give an undertaking to the robot to meet the necessities wanted for the proper orthodontic treatment. Human and computer participation is the key element for the advancement and the future research has to focus on 3D virtual showcase of the orthodontic appliances, a virtual expectation of the treatment. It is tough for the robotic to perceive working circumstance with the limitations of the structures of the oral cavity space that's why there may be constantly a want for the human component inside the treatment. Robots are meant to be flexible reliable and accurate, however all of that is constrained the space of the oral cavity thats traits back meant to ought to be made to lessen the diploma of freedom of the robots. Research has to focus on the spring- back and bending algorithm for the archwire bending robots. New researches needed about the orthodontic archwire physical properties to enhance the work precision of the archwire bending robots [10].

DISCUSSION

In orthodontics there has always an attempt to improve efficiency and efficacy of appliances. Since its beginning,

numerous modalities have been changed and improved to expand quality to the furthest extent. A number of recent studies that were conducted to evaluate the use of robots or machines to bend the archwire that is used in the orthodontic fixed appliances to the desired shape and reached the result that the use of a robot when compared to the conventional archwire manufacturing can improve the reproducibility, efficiency and the quality itself of the orthodontic treatment. Another study has found that the archwire bending robot had a significantly higher mean grades in accuracy when compared to a skilled professional orthodontic practitioners that were given the same tasks of the robot. The specialists got a mean score of 6.9 and it was compared to the mean score of a robot which was a 9 in case of accuracy. The use of a robot in the archwire bending process is a rapid and accurate design that can enhance the treatment time and the patient comfort thus enhances the outcome, this makes the use of robots to bend the archwire a very good option if not superior to the conventional methods in selecting the treatment options, this was supported by a number of studies. The most widely recognized procedures that utilize the robots in archwire twisting are insignia and suresmile which have demonstrated their prevalence upon different strategies.

CONCLUSION

Superelastic and complicated shape is the characteristic of formed archwire. It is very difficult to bend archwire into desired configuration. Traditionally, formed archwire is bent by orthodontist or technician by manual operation. Manual method needs revising many times which leads to a waste of time and the increase medical expenses per patient. Furthermore, the accuracy is low. Orthodontic treatment which utilizes a robot or a machine to twist the archwire that is utilized in fixed orthodontic appliance will have a vastly improved result with a strikingly less treatment time.

REFERENCES

1. Benson PE, Javidi H, Dibiase AT. What is the value of orthodontic treatment?. British Dental J. 2015;218(3):185-190.
2. Yongde Z, Chunge W, Jingang J, Jixiong J, Yi W, Yong W, et al. Motion planning for archwire bending robot in orthodontic treatments. Int J Contr Automa. 2014;7(7):287-298.
3. Jiang JG, Zhang Y, Wei C, He T, Liu Y. A review on robot in prosthodontics and orthodontics. Adva Mech Eng. 2014;7(1):198748.
4. Bhat BD, Bhandary S, Naik R, Shetty D. Robotics in dentistry: Fiction or reality. J Dent Res Rev. 2017;4(3):67-68.
5. Aldrees AM. Do customized orthodontic appliances and vibration devices provide more efficient treatment than conventional methods. Korean J Orthod. 2016;46(3):180-185.
6. Moles R. The SureSmile system in orthodontic practice. J Clin Orthod. 2009;43(3):161-174.
7. Zhang Y, Jia Y. The Control of archwire bending robot based on MOTOMAN UP6. Int Confer Biomed Eng Inform. 2009.
8. Jiang J, Wang Z, Zhang Y, Yu X, Guo X, Liu Y, et al. Recent advances in orthodontic archwire bending robot system. Recent Patent Mech Eng. 2016;9(2).
9. Gilbert HB, Webster RJ. Rapid, reliable shape setting of superelastic nitinol for prototyping robots. IEEE Robot Autom Lett. 2016;1(1):98-105.
10. Kumar P, Dixit P, Kalaivani V, Rajapandian K. Future advances in robotic dentistry. J Dental Health Oral Disor Ther. 2017;7(3):278-280.