



Review Article

Applications of robotics in orthodontics in COVID-19 pandemic

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ABSTRACT

Our intelligence is what makes us human, and robots are an extension of that quality. Robots play an important role in providing physical subordinates and even companionship in today's medical world. Orthodontics has always endeavored to improve the efficacy and efficiency of its appliances. The use of robots gives precise outcomes in less time and also reduces the risk of infection. This paper intends to collect literature from PUBMED, PUBMED central, Google Scholar and Scencedirect on uses of robotics in orthodontics. The review enumerates the applications of robots in orthodontic and orthognathic procedures which can be easily programmed and performed with almost negligible risk of disease transmission. During the COVID-19 pandemic, robots would prove to be great assistance. The paper presented can prove to be a boon in the present scenario. The review also makes few recommendations by which orthodontists can practice better without any risk.

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1. Introduction

Robotics, one of the most exclusive purviews of science fiction, is now approaching a point at which it is capable of having a dramatic influence over humanity and the medical industry. Robots efficiently carry out a series of actions, both simple and complex instinctively with the aid of computer programming. A robot increases the productivity of the workers, does treacherous work and also accomplishes some work where the human is not proficient.¹

COVID -19 outbreaks has spread across the globe making it a worldwide pandemic. COVID -19 is a RNA virus (SARS- coV-2) belonging to B lineage of beta-coronavirus.^{2,3} There have been several reports suggesting that person-to-person transmission is a likely route for spreading COVID-19 infection.⁴ To date, there is no peculiar antiviral drug or vaccine for the treatment of COVID-19 infection.⁵ There are specific guidelines constantly updated by the World Health Organization

(WHO), the most important ones being maintaining one-meter distance, hand washing for 20 seconds and avoiding regular touching of mouth and nose. For any oral physician, abstaining from regular inadvertent touching of the mouth and nose is difficult and insurmountable. There are shreds of evidence in which dentists are being infected with this pandemic disease.

Presently, the disease seems difficult to eradicate, causing us to take regular precautionary measures. There are guidelines for orthodontic emergencies reported in the study of Caprioglio et al., 2020 which should be followed by every orthodontist.⁶ Since the risk of orthodontists being infected from COVID-19 secondary to aerosol exposure from an asymptomatic yet positive patient is quite high, the implementation of robotics in orthodontics can prove to be a hopeful tool in the prevention of such transmission of COVID- 19.

Patient protection from COVID-19 infection can be attained by carefully following all the laid guidelines but complete clinician protection is still unguaranteed. The emergence of robots in the field of orthodontics,

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would be advantageous in various aspects like mini-implant placement,⁷ orthognathic surgeries,^{8,9} appliance fabrication,^{10–12} etc. In the present paper, we have performed a literature search from the online databases, tabulated a result, discussed the outcomes and formed a conclusion.

2. Materials and Methods

In order to identify all studies that examined the application of robots in dentistry, we performed a computerized search from online databases like PUBMED, PUBMED central, Google Scholar and Scencedirect (from 1987-2020). Robotics in orthodontics, archwire bending robots, orthognathic surgeries were searched in the subject heading. Only articles which satisfied the following criteria were included:

1. Articles written in English.
2. Original researches.
3. Articles based on experimental trials.

The exclusion criteria include:

1. Articles in languages other than English.
2. Review articles.
3. Editorial articles.
4. Letters to the editor.
5. Experimental studies with animals.
6. Short communications.

3. Results

The database search identified 109 articles out of which 14 articles met our inclusion criteria, which were on original studies and independent inventions. This can be shown by a flow diagram (Figure 1).

Table 1 sows summary of 14 studies with subheadings comprising of author and journal, year of study, invention and inference of the invention. Out of 14 studies, three studies were on archwire bending machines for forming and bending archwires. Two studies were on the formation of lingual archwires and brackets with the help of robots. Further, three studies were on customized orthodontic appliances made by robot. Additionally, one study was on the role of robots in mini-implant placement. Further, two studies were on the usefulness of robots in orthognathic surgeries. Additionally, one study was on bracket mounting procedure with the help of robots. Another study was on the effectiveness of robots in virtual treatment planning. At the end, one study was on the latest technology like aligners which are also made by robots and the last study was on the usefulness of patient robots.

4. Discussion

Various applications of robotics; archwire bending machines in orthodontics which further will be helpful

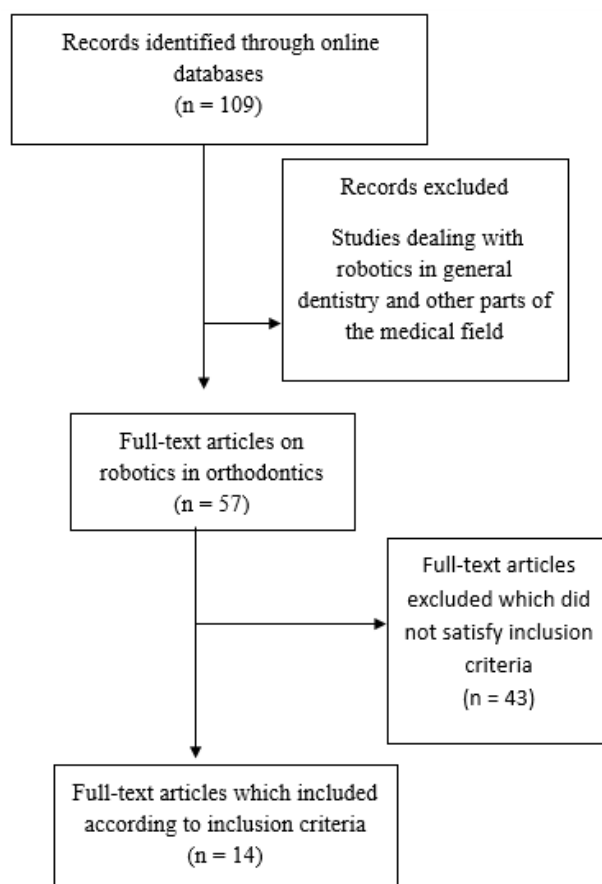


Fig. 1: Flow diagram of data search

in the COVID-19 pandemic were selected as topic. Furthermore, we found the various orthodontics procedures and orthognathic surgeries done by robots. The databases PUBMED, PUBMED central, Google Scholar and Scencedirect were found to be fairly beneficial for this paper.

The results of the present study showed the use of archwire bending machines to form and bend the archwires to the desired shape as per required for the orthodontic fixed appliances. The mentioned studies proved that with the help of archwire bending apparatus the reproducibility, efficiency and quality of the orthodontic treatment was improved when compared to conventional archwires manufacturing.^{13–15} Robots were helpful in lingual orthodontic as well, by forming lingual archwires and brackets which were reported in previous studies.^{17,18} By using robots there will be no infection from models, patient chair time will reduce and a large number of patients can be seen in a short time.

The study found that the customized brackets formed by robots were more effective in treatment than in conventional bracket systems. Bracket mounting position has a marked influence on the orthodontic treatment progress as it saves time, improves efficacy. This also decreases the chair

Table 1: Summary of all the studies

S. No.	Author and journal	Year	Invention	Inference of the study
1.	Wolfgang Orthuber United States Patent. ¹³	1987	Archwire bending machine.	Automatically bent and twisted the entire archwire.
2.	Tomo et al. United States Patent. ¹⁴	1994	Wire bending apparatus.	The apparatus comprised of a robot hand which had a device that gripped and rotated the wire. Therefore, multipurpose purposes can be accomplished without a large amount of labor.
3.	Kanamori. United States Patent. ¹⁵	2001	A bending device having a control mechanism for controlling joint type robots.	The joint type of robot shortened the working time. Working data was easily corrected and work can easily be unloaded and delivered without enlarging the device size.
4.	Mah J, Sachdeva R. Am J Orthod Dentofacial Orthop. ¹⁶	2001	Sure Smile process.	The device provided a high-quality and efficient treatment.
5.	Eric Kuo and Ross J. Miller. Am J Orthod Dentofacial Orthop. ¹⁰	2003	Automated custom-manufacturing technology in orthodontics.	The technology made appliances in less time and a repeatable, consistent fashion.
6.	Butscher et al. United States Patent. ¹¹	2003	Robot and method for bending orthodontic archwires and other medical devices.	Robot formed archwires with any required second and third order bends in less time with high precision. Helpful in manufacturing a large number of appliances and medical devices.
7.	Dirk Wiechmann et al Am J Orthod Dentofacial Orthop. ¹⁷	2003	Robotics for customized brackets and archwires for lingual orthodontics.	The study reported that brackets and archwires were customized according to the requirement.
8.	Tamer Theodossy and Mohammad Anwar Bamber. J oral and Maxillofacial Surgery. ⁸	2003	Role of robots in orthognathic surgery.	Robot arm played an important role in the stage of model surgery.
9.	Benedict Wilmes; Dieter Drescher. Angle Orthod. ⁷	2009	Robots used as a measurement system.	Predrilling diameters and insertion torques of mini-implants were measured by a robotic system.
10.	V. M. M. Vieira et al. Proceedings curac2010@MEDICA. ⁹	2010	Light weight robots.	This was used as assistant in orthognathic surgery.
11.	Wiechmann et al. United States Patent. ¹²	2010	Modular system for customized orthodontic appliances.	This invention included several independent inventive features that provided substantial improvements to the prior art. The greatest benefits were achieved for lingual treatments, but labial treatments were also benefited.
12.	Alfredo Gilbert. J of clin orthod. ¹⁸	2011	LAMDA (lingual archwire design aid.	This third generation wire bending robot formed more accurate bends.
13.	Hilliard. United States Patent. ¹⁹	2011	Robotic system for forming features in orthodontic aligners.	The system modified and formed features in conventional polymeric shell aligners.
14.	Katsuyoshi Futaki et al. Dental, Oral and Craniofacial Research. ²⁰	2016	Patient Robot.	This was useful in orthodontic bonding practice.

time and resulted in accurate positioning of brackets and reduces transmission of disease. The authors of the previous study also concluded that the appliance design can readily be optimized at any time while traditional optimization required huge resources.¹⁷ The appliance customization with the assistance of robots has increased precision and reduced the time of construction and will be very beneficial in this present status.^{10–12} With the help of 3D imaging, a virtual treatment plan could be formed which was efficient and high in quality.¹⁶ Cephalometric analysis can be performed, virtual models are more accurate than conventional ones which save time and provide accuracy and the data can be stored as long as we needed. Robots provide accuracy in measuring torque values and insertion depth in a more precise manner in mini-implant placement.⁷ This minor surgical procedure done by robots reduces the chances of failure of mini-implant placement, saves time and reduces the risk of infection.

The study also found that robots provide proper repositioning of the maxilla and mandible with accurate measurements providing accurate model surgery as reported by previous studies.^{8,9} Robotic surgeries provide accurate results, fewer chances of infection and less clinician exposure to contaminated blood and saliva. Advanced technology designed by robots like aligners were reported in the previous study.¹⁹ It was also reported in previous studies that the patient robot was useful in orthodontic bonding practice and also have an excellent educational effect.²⁰

In this digital era, where everything is online, robots will help keep the records of the patients and in managing the appointments. This will also develop loyalty and trust with the patients and help orthodontists attract more individuals with malocclusions for orthodontic treatment. By using robots, orthodontists can sit in transparent chambers distanced from the patient, program robots to perform the procedure and with the aid of an intraoral camera; orthodontists will be able to evaluate all the procedures done by robots on the computer screen. These data can also be saved for future records and research purposes.

5. Conclusion

The review concludes that the applications of robotics in orthodontics decreases the labor intensity and also improves the orthodontic process. With the emerging new technology, orthodontists can easily practice orthodontics and orthognathic procedures in this COVID – 19 pandemic without the risk of being infected. With the help of robots orthodontists as well as patients will be protected and the risk of transmission of COVID – 19 virus from person to person will be prevented.

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7. Conflict of Interest

None.

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