

# TRACKING OF ORTHODONTIC TREATMENT USING VARIOUS TECHNOLOGY

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**Abstract:** Around 75% of the world's population has some or the other type of orthodontic problem. One of the most found orthodontic problems is crooked or misaligned teeth. The treatment for this problem is braces. Braces have been used since the early 18th century with improvements made in them over a period. Braces are permanently fixed on the teeth of the patient which cause various hygiene and allergic problems. The solution to this was the introduction of aligners which are removable and solve all the drawbacks associated with braces. As the aligners are removable, they cause another sort of problem which is the difficulty in tracking the efficient usage of the braces. This paper will look at the difference between the braces and Aligners and the various techniques available for tracking the usage of the aligners.

**Keywords:** Aligners, Braces, Orthodontic.

## 1. INTRODUCTION

Aligners are next-generation alignment equipment used to treat orthodontic problems. Aligners can treat most, but not all, orthodontic problems. They are made of plastic and are custom made to fit your teeth. Each aligner moves the teeth step by step towards the final position. Small bumps of composite resin (tooth-coloured filling material) are attached to various teeth to help the aligner grip the tooth so it can be moved correctly. [1]

Aligners are a replacement for Braces which are made of metal or porcelain and are attached to the teeth. Metal wires and rubber bands are then used to provide a force to help the teeth move into the correct position.

## 2. EVOLUTION OF ORTHODONTIC TREATMENT FOR TEETH ALIGNMENT

Orthodontics is a fairly advanced science these days, and multiple treatment options are available to patients with different conditions, such as orthodontics, occlusion readjustment, and palate widening. Orthodontics is what it is today after centuries of practice and research.

### 2.1. The beginning of orthodontics

The earliest evidence of orthodontic treatment dates back to ancient Egypt. In ancient Egypt, mummified remains were found in metal bands wrapped around teeth and are thought to represent the primitive form of orthodontics. In the 5th and 6th centuries BC, Greek doctors Hippocrates and Aristotle proposed different theories on how orthodontic teeth. [2]

In the early 1700s, the medical text "Surgeon Dentist" was published in 1728 by a study by the French dentist Pierre Fauchard, known as the "father of modern dentistry". In this volume, he proposes a series of "braces". "It can be used on the patient's teeth to straighten and readjust the patient's teeth. He also found that the orthodontic process is easier to perform in children than in adults because children have smaller roots. [3]

## 2.2. The first "modern brace"

It took another 90 years before the first "modern" brace was developed by another French dentist, Christoph Francois de la Valle, in 1819. It consisted of a series of wires "cribs" wrapped around the teeth in pairs, holding the teeth together in place. Over the next century, the work of many professionals has progressed to improve treatment efficiency and patient comfort. Doctor in 1843. Edward Maynard first used elastic bands in combination with braces to improve jaw alignment. In 1864 Dr Barnum invented a dental dam that helps protect the patient's gums when the patient is receiving the brace. And in the early 1900s, Henry Albert Baker worked to eliminate the need for tooth extractions of selected teeth to promote effective orthodontic treatment.

Over time, the designs, materials, appearances, and methods used in orthodontic braces have changed and changed in many ways. However, although the true representation of modern brace was first designed in the 1970s, they contained some features that no longer existed. [4]

## 2.3. Modern Orthodontics

Today, orthodontics is more advanced than ever to provide fast, efficient and quality treatments while maintaining superior comfort for patients. Modern metal braces are less noticeable than ever, and alternatives such as clear ceramic braces and lingual braces located on the lingual side of the tooth provide patients with an additional level of discretion. These new designs usually provide results in 1-3 years and are much faster than the old ones. And with advances in chemistry and biology knowledge, metal clasps are now made of 100% stainless steel. It is non-toxic compared to certain materials used in the past. [3]

In addition to this, there are new treatment options for clear aligner therapy. A clear aligner is a set of clear medical grade plastic retainers that are cast from a tooth mould and gradually modified by an orthodontist to apply pressure to the teeth and readjust over time. Clear aligners are barely visible, and in some cases have been shown to work faster and more effectively than metal braces, and are removable, making patient dental hygiene much easier than metal or ceramic braces. Will be. They provide patients with a much higher level of comfort than modern metal braces and eliminate annoying, pointed wires and staples from the equation. They also offer an alternative to traditional braces for people with certain medical conditions that prevent them from getting traditional braces. [3]

## 3. DIFFERENCE BETWEEN TRADITIONAL BRACES AND ALIGNERS

### 3.1 Difference between aligners and braces

**Appearance:** The aligner is transparent and has a custom fit to the teeth, making it less noticeable than braces. Brace stands out more than the aligner. This is important for some patients, depending on their profession, hobbies, and personality. [5]

**Diet:** Eating with the aligner removed does not affect your diet. When you put a brace on your teeth, you need to change your diet. Hard foods can cause fractures and can slow or stop the progress of treatment [5]

**Hygiene:** The aligner is removable so you can brush and floss as usual but It's much harder to clean your teeth with braces than with an aligner. [5]

**Comfort:** In general, aligners are more comfortable than braces and braces can rub your cheeks and lips, which makes them more likely to cause discomfort. [6]

**Efficacy:** Aligners can treat most, but not all. Aligners can handle most cases, but braces can be used in all cases. [6]

**Cost:** In some cases, the cost of the aligner can be higher than the brace. However, they are often similar or the same. [6]

#### **4. SCANNING REQUIREMENT FOR CREATION OF TREATMENT PLAN**

The scanning of the patient teeth and jaw structure is done before to ensure that a proper treatment plan can be generated, and a potential treatment action can be taken currently there are two major mentors used for the scanning of the teeth

##### **4.1. Molds**

There are a few materials used to make impressions of the teeth. Perhaps the most used material is called alginate. It is a powder compound made from seaweed or kelp that is added to water to make something that looks silly putty. It usually only takes about 60 seconds to harden. An alternative material used is called vinyl polysiloxane (VPS) This is a silicone-based material that can take anywhere from 25 minutes to set properly Orthodontists might also use polyethers to create an impression The impression material is loaded into a plastic tray that looks like a mouthguard. Then put the splint in your mouth and press it around your teeth and gums. It is usually pressed against the lower jaw first. It stays in place until the material you are using cures (or dries). Then it is removed and the impression of your teeth is taken from the resulting negatives.

##### **4.2. 3D Scanning**

The transition from orthodontic rings to brackets has been made possible by advances in dental materials. The use of clear aligners is driving the research and development of new materials, especially for direct 3D printing. 3D printing, also known as additive manufacturing, dates back to the 1980s and is now increasingly used in the fields of dental and medical modelling. It is used in various applications such as oral surgery, prosthodontics, restorative dentistry, orthodontics, implant science, and instrument manufacturing. With 3D printing, you can create parts on a layer-by-layer basis instead of traditional manufacturing methods that rely on machining, moulding, and subtractive colour mixing. Materials currently used for 3D printing of orthodontics include acrylonitrile butadiene styrene resin, stereolithographic material (epoxy resin), polylactic acid, polyamide (nylon), fibreglass-reinforced polyamide, silver, steel, titanium, and photopolymer. And so on. Contains wax and polycarbonate. Using the 3D printing model was the first step in minimizing errors and errors (such as geometric inaccuracies) that occur during impression taking. Instead of using error-prone gypsum models that scan and model to develop different alignment stages, we recommend using digital impressions and 3D printing to improve. Using a 3D-printed clear aligner for direct use eliminates the cumulative errors caused by analogue impression acquisition and subsequent thermoplastic workflows. In addition to higher accuracy, direct printing offers other benefits such as shorter supply chains, significantly shorter lead times, and lower costs. It's also a more sustainable process. [7]

[8]

#### **5. NEED FOR TRACKING USAGE OF ALIGNERS**

Clear aligners have become a common treatment option for many adults and teens seeking to improve smiles and occlusion while avoiding traditional brace therapy. This approach uses a series of clear aligners to slowly move each tooth to the desired position. This approach significantly improves the quality of patient care, but for example, regulated compliance that requires wearing an aligner 22 hours a day leads to poor patient observance. Given that this discipline must be maintained throughout the treatment period, the treatment period is an important determinant for future patients. [9]

Non-compliance with computer-generated movements is clinically demonstrated by improper aligners that impede the progress of treatment. This is also known as "non-tracking" and can be due to several factors, including: (1) Patients who do not wear the aligner completely for 22 hours a day, (2) Individual differences in tooth movement, (3) Increased requirements for tooth movement for each aligner, (4) To the next aligner Patients switching too quickly, (5) aligner's suboptimal power transmission system, and (6) different teeth (from a biological point of view) from person to person that current improvements in materials science are trying to overcome the rate of motion. Even with all these factors in mind, slow tooth movements prevent one-liner from progressing to the next. [9]

The control group (no vibration, aligner changed every 14 days) showed 84% of the predicted tooth movements. The 7sham group had 70% less follow-up and was statistically significant ( $P < 0.02$ ) when compared with the control group. However, when subjects changed aligners every 7 days and received vibration (7- vibration), tracking improved significantly to 90% ( $P < 0.003$ ), but it was not significantly higher than the control group ( $P > 0.05$ ). When the aligner interval was shortened to 5 days (5 sham), the teeth did not move according to the prognosis of ClinCheck, and when I tried to switch to the second and third aligners, the aligner did not fit well, so I could proceed with treatment. I could not do it. Therefore, participation in the study was suspended for the benefit of the subjects. However, when the 5-day group received vibration stimuli (5 vibrations), good follow-up was observed (84%), which was statistically more significant than the 7-sham group ( $P < 0.022$ ) but insignificant statistically from the control or 7-vibration groups ( $P > 0.05$ ). [9]

## 6. Tracking Usage using Mobile Application

As we have seen an immense increase in the use and market of smartphones over the decade, mobile applications play a crucial role in day-to-day life. They at this point play a logically huge occupation in the everyday presence and patients' casual networks like Instagram tends to be a manual for the standard verbal motivation performed by orthodontists towards young patients under orthodontic treatment. With the amount of orthodontic related applications continuing to augment, and the quick improvement of Artificial Intelligence, the likelihood to yield huge benefits to the two clinicians and patients is clear. More advanced features of artificial intelligence have been familiar with orthodontic applications lately. For instance, three-layered convolutional neural networks (3D CNN) have a high potential for automatized 3D cephalometric assessment straightforwardly from the Cone-beam computed Tomography (CBCT) or facial development expectations. [10]

The current scenario suggests that there are only 20 publications based on apps used in orthodontics. The studies consisted of randomized controlled trials (RCT), case controls, cohort studies, and cross-sectional studies. The studies based on apps used for diagnostics consisted for 35%, apps used for reminders consisted for 41%, and remote monitoring apps were about 24%.

**Table 1. The characteristics of current studies about apps used in orthodontics [10].**

Study Type	Author	Domain of use	Focus group of apps
RCT	Alkadhi 2017	Reminders	Patient
RCT	Deleuse 2020	Reminders	Patient
RCT	Li 2016	Reminders	Patient
RCT	Scheerman 2020	Reminders	Patient
RCT	Zotti 2016	Reminders; remote monitoring	Patient; Clinician
RCT	Zotti 2019	Reminders; remote monitoring	Patient; Clinician
RCT	Al-Abdallah 2021	Reminders	Patient; Clinician
RCT	Ross 2019	Reminders	Patient
Case-control	Abdul Khader 2020	Diagnostics	Clinician
Case-control	Aksakalli 2017	Diagnostics	Clinician
Case-control	Goracci 2014	Diagnostics	Clinician
Case-control	Kumar 2020	Diagnostics	Clinician
Case-control	Kuriakose 2019	Remote monitoring	Patient; Clinician
Case-control	Livas 2019	Diagnostics	Clinician
Case-control	Morris 2019	Remote monitoring	Patient; Clinician
Case-control	Moylan 2019	Remote monitoring	Patient; Clinician
Case-control	Sayar 2017	Diagnostics	Clinician
Case-control	Caruso 2021	Remote monitoring	Patient; Clinician
Retrospective cohort study	Hansa 2020	Remote monitoring	Patient; Clinician
Cross- Sectional	Underwood 2015	Reminders	Patient

Tele-orthodontics-Dental monitoring (Dental monitoring Co., Paris, France) with remote checking is the ongoing reality in orthodontics. We can, as clinical orthodontists proactively screen our patients with virtual appraisals to upgrade chairside courses of action. The Unmistakable Aligners Treatment, when in doubt, is leaned on patients' indiscipline. Patient not wearing aligners suitably (above 22 h every day), achieves a situation called "non-following". This shows up as a mistake between the condition of the aligner and authentic teeth position. In any case, it is beneficial for both the orthodontist and the patient, as the orthodontist can additionally foster treatment and chairside viability, while the patients can avoid the additional cash and time costs of going out to the training. Rather than standard modified aligner changes, the patients get seven days by week "GO" or "Off-limits" advance notice. "Off-limits" advance notice is serious about what's going on was not evaluated as sensible for aligner change and the patient should stay on the current aligner short of any extra movement in the treatment. The orthodontist is instructed when Off-limits advance notice is sent, and individual teeth following issues, appalling oral neatness, or broken associations can be recognized.

## **7. TRACKING USING SPECIALLY BUILT CUSTOM BOX**

### **7.1. Sensing Methodology**

By studying the bigger version of a Load Cell used to weigh the mass of 50000grams, it was noted that it would be a perfect fit, provided it is connected to the Centre of Gravity of the box. The method used for measuring includes one sensor placed at the Centre of gravity of the box. But the actual product required a smaller size of the load cell, which was high-priced, thus it was not feasible to use the load cell. [8]

### 7.2. Software Algorithm

The software that monitors the control message, is designed on the ARM platform using Keil Software. There are 3 basic modes for this system:

- i. Time and Date
- ii. Set Frequency and Alarm.
- iii. Display Mode

### 7.3. Working and Operation of the System

The smart box consists of two major parts: the Sensor board and the Control board. The sensor board was made using the OrCAD PCB wizard. The individual sensor is connected to the inter-face board designed, based on the principle of the astable multivibrator. The sensor output is multiplexed to the controller board (LPC2148) via the multiplexer IC. Microcontrollers output is fed to selector lines The LCD module is used for display operations and Buzzer for the alarm function. The following are the steps for the operation [8]



Figure 1. Flow Diagram of Working of Smart Pill Box [8]

- i. **Set Time and Date**- Two selection options are given to adjust the date and time separately. Within the date or the time option, we can increment the values by using a loop and check function.
- ii. **Set frequency and alarm**- The Set Medicine Frequency module is for allowing the user to set the frequency of the medicine in a day and set the convenient time for the alarms. After the normal mode of execution, the alarm function checks for the time to map with the set alarm values. GSM module activates via the UART message to contact the user once the

- result yields positive. To enable the snooze option, the alarm variable is incremented twice thereafter. If the person fails to take the pill on time, the same process is repeated thereafter.
- iii. **Display:** It is the normal mode of operation. It works by no human intervention and displays the present time and date of the day. Once the box is closed, the count variable is monitored for incremental updating. If it fails, then the snooze operation will be executed. otherwise, the next alarm value will be added to the Alarm registers.

## 8. AI APPLICATION

Mobile application StrojCHECK® (Bratislava, Slovakia, 3Dent Medical, osim.sk—Society for Medical Innovation (SMI)) is a free smart app for orthodontic patients and doctors [11]. The overall presentation of this application's motivation very well may be summarized that this smart app is utilized for laying out appropriate treatment schedules for orthodontic patients. This application assesses exercises enlisted by understanding, spurs and teaches the patient empowering him to accomplish appropriate standards of conduct connected with fruitful treatment. This app was tested for usage before and after the AI update. 86 subjects (32 Males and 54 Females) using this app were monitored 60 days before the AI update and 60 days after the update. That exhibition of patients collaborating with the application (after the artificial intelligence update) won't be essentially not the same as the time preceding the update. In general, the artificial intelligence update of the application came about fundamentally better clinical performance. [12]

### 8.1. Limitations

Appropriate examinations might have been missed assuming they were distributed in a language other than English or data sets not looked at in this study. Additionally, an examination might not have been seen due to the search terms utilized. An application, by definition, is programming planned explicitly for cell phones and incorporates mobiles, tablets, and watches. These applications are especially fit for customers and might be most suitably utilized for updating treatment or helping with remote checking. [13]

## CONCLUSION

This paper, the evaluation of orthodontic treatment over the years. With the introduction of Braces to treat the crooked or misaligned teeth to the latest and most advanced technology of aligners. The differences between the braces and aligner treatment were discussed. It is widely accepted that the aligner option is better than the traditional practice of using braces. Almost all orthodontic treatment can be done using aligners but in some case, the aligners cant be used in this case traditional braces needs to be used. As the aligners are removable it is difficult to track their usage as the efficiency depends on the compliant usage of the aligners. Various technologies for tracking the usage of the aligners are discussed in the paper. The app-based approach is simple but is not an efficient approach as the usage data needs to be entered into the system. Another approach would be to use a smart box which is loosely based on the concept of a smart pillbox. The box will provide a reminder to the patient to wear the aligners when he/she are not wearing the aligners for a long time. Combining this with the help of AI can help in increasing the efficiency of the treatment.

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