



The Future of Customised Orthodontics Care- A Scoping Review

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ABSTRACT

The field of orthodontics is pacing towards a state-of-the-art technological evolution in its new era. Software integration (CAD CAM) of digital models, three-dimensional facial imaging is instrumental in simulating a viable treatment plan and strike right chord of communication with the patients. A diligent dexterous effort towards fabrication of an orthodontic appliance is crucial to deliver reproducible, yet desirable results all the time. 3D printing technology has shown its mettle and continues to grow in terms of applications. This review focuses on customized appliances for orthodontic treatment. With advancement in medical imaging, there has been a technological revolution in Orthodontics and dentistry. In recent years dental aesthetics have undergone a dramatic boom. For Orthodontists and dentists, it is important to know about new technology and how it assists and maintain quality in orthodontic treatment outcome.

Keywords: CAD-CAM, lingual orthodontics, Invisalign attachments, Insignia, Memotain.

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INTRODUCTION

One of the most well-known concepts in the world of facial beauty is Ideal Proportions. The art of cosmetic dental dates to over four millennia[1-2]. The contributions by dental professionals in terms of aesthetic dentistry is uplifting the lives of all the people in various phases. Dental aesthetics not only confines to enhancing a person's look, but also boosts self-confidence bringing joy in their life. Orthodontists and dental specialists are turning towards digital treatment planning. Quality-orthodontics requires customized appliances with good performance for better diagnosis of an individual and treatment planning for desirable outcome of particular orthodontic treatment that will enhance the aesthetics of an individual and also provide a stable occlusion. Earlier all patients were given the similar treatment procedure regardless of the different individual structures of their particular dentition[3]. For example, the current bracket system uses average tooth shape but majority of the patients does not have average teeth size and shape. With time and advancement, technology is bringing an effective and more efficient orthodontic experience for patients as well as for the orthodontists. Practice management software, radiographs and diagnostic models are all shifting to digital format [4].

A technological revolution has been stirred up in medical imaging, Orthodontics and dentistry owing to the concepts like 3D printing and customization of appliances and devices [3, 4]. Unparallel efficiency rate and accuracy in results followed by visualization of treatment are few of the products of the modern computer aided technologies. It has become almost a routine work to use CAD-CAM techniques to carry out virtual treatment planning. Customization leverages arch wires, individualized bracket slot/base or combination of these 2 approaches to bring into place an ideal force system and produce desired tooth displacement[5-6].

Digitization is not left behind and has slowly stepped in the world of orthodontics through aligner therapy, direct bracket printing (Incognito system), and robotic wire bending. Digital technology permits construction of indirect bonding trays which are printed directly, moreover the brackets are placed into the planned position. Amidst the Covid-19 pandemic regulatory bodies had to halt elective and routine dental procedures including orthodontic treatment. It seems need of the hour to manufacture appliances according to the requirements of the patients. Aligner treatment is all set to replace braces with the manufacturing of printed shape memory plastics. High inclination towards social media for information and digital treatment planning by orthodontists and specialists have been observed [7].

LINGUAL ORTHODONTICS

Crucial factors in biomechanics of lingual brackets are alignment, levelling, space closure and torque control. In case of mesio-distal angulation from canine to canine, inter canine distance, molar relation, horizontal and vertical overlap customized lingual appliances are most beneficial⁶. Most dissimilarity in torque given in bucco-lingual direction between setups and post-treatment models were detected for maxillary lateral incisors, both premolars and molars, in addition to mandibular incisors and molars. Nevertheless, if a three-degree threshold were measured clinically significant, and the loss of torque control would be significant only for the maxillary second premolars and the first molars also [8].

Lingual jet appliance:

In 2008 the primary beta version of the Lingual jet appliance was introduced and offered at the European Society of Lingual dental orthodontics (ESLO) convention. For the first time orthodontists are able to use a customary from straight arch wire in software generated brackets all adaptable to accommodating themselves utterly to the extremities forced by variations in dental surfaces and therefore the need of the straight wire technique [9]. Manufacturers too have shown a major shift towards CAD/CAM manufacturing techniques which are centred on intraoral scans or digitized plaster models, over traditional process of containers[10-11] and the year of introduction of appliances depicted in table 1. In contrast to the old methods like cortical(bone) incisions accomplished using a carbide bur, capable of damaging the roots of neighbouring teeth, we now have easier means like piezoelectric surgical micro-saw. To overcome these challenges, we now have piezoelectric surgical micro-saw which is an advanced and marginally less invasive procedure coalescing piezoelectric surgical cortical(bone) micro-incisions using three-dimensional printed surgical guide. It completely removes the need for flap elevation.

Table 1. Depicting Year of introduction of customized appliances

S.No.	Year of Introduction	Appliance	Introduced by
1.	1974	CAD CAM	Mormann and Brandestini
2.	1979	Lingual orthodontics	Dr. Craven Kurz
3.	1997	Clear aligner therapy (CAT)	Zia Chishti and Kelsey Worth
4.	1998	Sure smile (commercially released in 2005)	Dr. Sachdeva
5.	2012	Customized bracket (INCOGNITO)	Dirk Wiechmann

Custom arch wires:

The records taken from the intraoral scanner is commonly used for the generation of virtual model of the individual dentition. The teeth can be moved to its required desired position. After taking the consent from the orthodontist for the virtual dental setup, with the help of exact location of the bracket slot on every distinct tooth, the computer aided design software assesses the bends in the arch wire for the desired dental setup. The robot bending system is used to bend arch wires in an appliance-manufacturing centre producing custom size bends [12-13]

Customized brackets:

Patient compliance and accuracy of the orthodontic treatment is high in customized brackets.

3.1 Lingual brackets: A technical setup is generated virtually to attain the final treatment outcome, followed by designing completely customized brackets for the exact fitting on the lingual/palatal surface of teeth[14-16]. After completion, the brackets are three-dimensionally printed in the wax, and afterwards casted using gold. To attain the distinct arch form wires are mechanically bent and the desired outcome is achieved. The output is highly precise, and completely customised lingual/palatal appliance which has a low profile which reflects or mirrors lingual/palatal tooth surfaces and reduces tongue discomfort [16]

3.2 Labial brackets: The practitioner starts by making a Polyvinylsiloxane (PVS) compound impression or else by taking intraoral scan of the individual dentition, that is generally passed on Ormco for the generation of virtual models of the maxillary and mandibular dental arch[17-18]

3.3 Time bracket: The time bracket contains a clip that turns into position round the gingival tie wing and pivots towards the occlusal instead of the gingival wall of the slot. The spring clip opens sufficiently so much for a wire to be embedded, however the gap is strained by a stop between the clip and therefore the bracket body. it's designed to be passive (minimal force and friction in starting time of treatment) and active (torque and rotational control in centre and finishing stage), Controlled torque and revolutions, straightforward to open during treatment and hygienic for patients.

CLEAR ALIGNER THERAPY

CAT was introduced to treat minor irregularities of tooth position solely. Digital technology permits us to design clear aligners supported by specific software package (CAD), and develop the devices themselves,

with the help of the technology of CAM 3D printers. In aligners the force system varies according to the mechanical characteristics of thermoplastic material, thickness of aligners along with the supplementation of auxiliary parts. At each and every stage of treatment production of physical moulds of the dentition is performed using rapid prototype method[19] The custom-made aligners are then manufactured using thermoforming method and cut to the ultimate configurations Treatments with clear aligners embrace open bite, deep bite, area closure, crossbites, Extrusion / sinking, category II and sophistication III cases[20]. Steps of aligner fabrication showing in Figure 1 and Invisalign attachments in figure 2 are depicted.

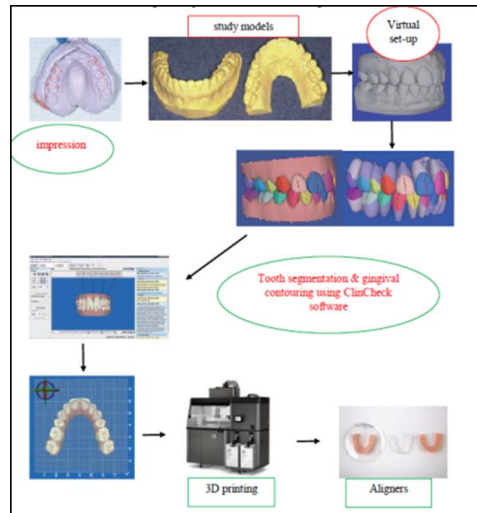


Figure 1. Steps of Aligner fabrication



Figure 2. Clinical appearance of Invisalign attachment

Movements like extrusion, correction of severe rotations, molar up righting, and closure of extraction areas are known to be more difficult to accomplish with aligners. Even so, incisor extrusion, molar transition, and closure of extraction areas are attainable with the utilization of attachments within the Invisalign® system. The primary Invisalign attachments included standard attachments which were either ellipsoid in shape or rectangular horizontal or vertical. In 2009, Smart Force Features, that included optimized attachments, were developed. Optimised rotation attachment is mechanically placed onto the canines or the premolars after a rotation of five degree is noticed and the top speed is two degree per aligner [21-22]. The addition of mini-screw anchorage to aid the biomechanics which involves elastic forces for extrusion of the anterior/posterior teeth is an alternative logical extension of their function to CAT(Aligners). An alternate kind of bootstrap mechanism employs mini-screws to enhance the dependability of intrusion in posterior region and possibly produce spontaneous mandibular autorotation [23].

SURESMILE

It is an all-digital system that uses new three-D imaging and computer aided techniques for designation and treatment planning and uses artificial intelligence to customise fixed orthodontic appliances. Sure Smile™ (OraMetrix, Richardson, Tex) is a computer-aided treatment conception introduced in 1998, however not free commercially till around 2005. The primary advantage of using application of CAD/CAM is improving reproducibility, efficiency, and quality of treatment. SureSmile technology was designed to substantially reduce errors in treatment ensuing from appliance management. It provides image capturing, three-dimensional image tools for diagnosis, monitoring, and patient communication, along with preciseness appliances which will facilitate the orthodontist deliver actually customized care in an

exceedingly patient-centered practice [24-25]. Robotic automation and advance technology offers multiple opportunities to enhance dental care. Automation could ease human sources for a lot of vital tasks, like communicating with patients as well as other alternative work which requires greater psychological feature skills.

Malocclusion is a common oral condition which not only affects the look but also the oral function and the health of an individual. Fixed orthodontic mechanotherapy is best and customary technique to treat malocclusion. Suresmile technology includes of 3 key elements Orascanner, three-D computer code and suresmile service center. Benefits of positive Smile embrace reduce errors in treatment ensuing from appliance management, provides image capturing, 3D visualisation of tools for identification, monitoring, and patient communication beside precision appliances that may facilitate the dentist to deliver actually customized care in a very patient-oriented apply.

Advantages of Sure Smile

1. Reduced undesirable tooth movement
2. Less chances of errors during selection of arch-wire
3. Bracket positioning errors may be reduced
4. Bonding adhesive thickness errors can be reduced.

RETAINERS

With the technological advancement and digitalisation of orthodontics, modern retainer styles, materials, and production methods are introduced. In contrast to standard procedure followed for production of conventional hawley's retainers, more producers are using computer-aided design and production which are based on intraoral scan or virtual dental plaster model. These modern computer aided design/computer aided manufacturer retainers varies in terms of their materials (mainly Co-Cr, titanium and NiTi) and production methods used [26].

Memotain could be a computer aided design/computer aided manufacturer fabricated lingual retainer which is made of 0.014 × 0.014-inch rectangular NiTi. As the NiTi wire is flexible & custom made to acclimatise exactly on the lingual surface of the patient's tooth. Pascal Schumacher invented memotain in 2012. The name is derived from the mix of "memory" and "retainer" as a result of the distinctiveness of using NiTi for lingual wire. It provides various benefits compared to conventional multi-stranded lingual wire as well as there is no need for wire bending/measuring, individually optimised placement, precision of fit, better inter-proximal adaptation, reduced tongue irritation, and also resistance to the microbial colonization[27].

Recent advances

Customized orthodontic implants are manufactured for the treatment of Obstructive sleep apnea. The determination and assessment of outcome needs a patient/individual documentation protocol, along with data acquired at standardized ages, to differentiate various kind of surgeries, their effects, also as between various rehabilitation centre [28-29]. Customized trays are created using cold-curing acrylic resin creating individual tray which is specific for each and every kid. The impression prevents the utilization of dental models for diagnosing, planning of treatment, also the research measurements. And customised trays raised the condition of impression, precisely creating the anatomical feature of the dental arches of babies having oral cleft [30].

CONCLUSION

The current mode of orthodontic appliance fabrication is backbreaking and requires greater skills for treatment completion followed by appliance delivery to the patient to achieve the planned results. In modern times, the advancements in technical aids and accessibility to computer software, has made it possible to produce customised scanned virtual impressions, to digitally design and three dimensionally print the variety of appliances which are used commonly in orthodontics. Thus, we conclude that customised orthodontics are going to be the future for clinical accuracy and patient-doctor's comfort.

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