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Review Article

# Precision orthodontics

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ABSTRACT

Precision medicine (PM) is an emerging approach that advocates tailoring healthcare by personalising medical decisions, treatments, behaviours, or goods to a subset of individuals rather than employing a one-drug-fits-all strategy. Molecular diagnostics, imaging, and analytics are examples of precision medicine tools. Precision medical advances foreshadowed comparable advancements in orthodontics, and they can be used to produce tailored treatment approaches and improve treatment efficiency. This article presents an overview of recent developments in computer technology and biomedicine, as well as their current and expected future uses in precision orthodontics. It is necessary to conduct an evaluation of orthodontically relevant technology and developments in relevant biological research. Within the next few decades, advances in computer software and hardware, as well as 3D imaging technology, will offer for more individualised therapy and biomechanical planning. The prospects for personalised orthodontic bracket's manufacturing with adequate material qualities and digital technology in the future are both appealing and persuasive.



## 1. Introduction

Precision medicine is a novel way of treating and preventing illness that takes incorporates human variations in genomes, lifestyle and environment. Orthodontics is a branch of dentistry that uses mechanical devices and pressures to regulate tooth position and promote craniofacial orthopaedics unlike many other medical and dental specialties, places a strong focus on technology.[1] As a result, precision orthodontics must go beyond the traditional notion of precision medicine, which focuses on a patient's particular cell biology and lifestyle, to incorporate personalised accessories and tissue stress distribution.Precision orthodontics could be a future soon,owing to the recent advancements in computational capabilities and versatility, three dimensional image analysis, proper knowledge of tooth movement and craniofacial osteo biology and rising novel sequencer and various genomic methods (For example, metabolomics, pharmacogenomics, transcriptomics and genomics) are all "omics" analyses.[2] The purpose of this paper is to offer background on current and expected technological and biomedical developments, as well as to illustrate present and anticipated uses in high precision orthodontics.

## 2. Orthodontic Precision with Growth and Technology

Computer hardware and software have evolved at a breakneck pace since the 1960s, and their uses have become pervasive in our daily lives. This progress has paved the way for the advancement of technologies including as 3D scanning and printing, digital reality and design, all of which are relevant and valuable in orthodontics. Furthermore, advances in communication technologies and

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portals enable users to access massive amounts of data and search capabilities. These are used not just by healthcare practitioners, but also by patients and the general public, necessitating the use of novel and verified ways in orthodontics to give personalised, efficient, and optimal care.[3]

## 3. 3D Imaging Technology

Volumetric 3D imaging obtained by computed tomography (CT) and magnetic resonance imaging (MRI) and interface images produced by digital models are the two types of 3D imaging available today. The combined efficacy of these methods goes beyond improved 3D dental and skeletal relationships diagnosis**.** Surgical orthodontic procedures can be performed in silico by capturing spatially precise images. In addition, through the bespoke manufacture of appliances, dental movements and skeletal components could be designed and converted into real functions utilising 3D printing technology. When it comes to treatment planning and implementation, this method offers numerous distinct advantages**.** Treatment planning in silico has the advantage of allowing for the incorporation of projected dental, skeletal and soft tissue changes. Dento-skeletal modifications must be designed immediately or sequentially using computerized better treatment plan, which develops a precise structural model of the cranium.[4]

As a result, personalised virtual diagnosis, therapy, and biomechanic planning may help to reduce problems, improve treatment efficiency and results. Dental arches are frequently decompensated and aligned before surgical treatment in orthognathic surgery patients to retain post-operative occlusal stability, however this might lengthen treatment duration and demand unstable teeth movements. Optionally, doing surgical procedures before completing sufficient dental adjustments can reduce treatment duration by offering beneficial biologic impacts that enhance tooth movements (e.g. regional acceleratory phenomenon or RAP), however it is quite challenging because the finished position of tooth and jaw relationships should be predicted. 3D digital treatment simulation enables for the custom production of surgical splints and metallic stainless steel archwires, allowing for the accurate planning and execution of both dental and skeletal movements. This technique had been demonstrated to significantly decrease treatment times, enhance decompensated jaw- tooth movements, and improve aesthetics.[5]

Several commercial programmes for 3D virtual treatment planning have been developed, however biomechanical planning of tooth movements are still in the works. Virtual Surgical Planning (VSP®) Technology (3D Systems; Littleton, CO, USA), Simplant and Proplan (Materialize; htt p://oo.simplant.com), and InVivo5® (Anatomage; San Jose, CA, USA) are just a few examples of surgical planning software that combine CT/Cone Beam CT (CBCT) data, 3D stereophotogrammetry, and intra-oral occlusal scans to develop a complete three dimensional view. The surgeon, orthodontist, and engineer can all collaborate together to replicate dental movements and surgical osteotomies. The finalized treatment plan is then transformed to an interim and definitive splint, that is commonly 3D design.[6]

## 4. Smart Appliances

Modern orthodontic appliances, such as those for ensuring cooperation and enhancing tooth and bone movements, will probably become more combined as sensor technologies, outcome and recording devices improve and costs fall. Despite the fact that compliance is an important component of successful orthodontic treatment and retention, surveys demonstrate that it is a key unknown variable in treatment outcomes. The SMART Retainer® and Theramon® are two commercially available removable retainers with microsensors for accurately detecting usage period and quantifying patient cooperation.[7] Other innovative application of such technique is monitoring the length of time that a protraction facemask is worn.[8] Additional research using this method could help to identify the best time to utilize a protraction facemask for best outcomes, while also correlate the effectiveness and efficiency of various treatment procedures to the length of time, they are worn and the magnitudes of forces they apply. Orthodontic equipment's force magnitudes and directions are still unknown and unpredictable. Measurement and application of controlled forces in orthodontic systems can be done in a variety of ways. Coils for data acquisition and transfer are also being developed, as well as engineering for calibration equipment for the new systems. Finally, arch wires, such as SmartArch® orthodontic wires, can be set to convey biomechanically optimum forces (Smart Alloys; Waterloo, ON, Canada). Programming the wire's strength to fit the demands of specific teeth may result in more efficient treatment and shorter clinical appointments for wire adjustments.

The real smart Retainer environmental microsensor was invented, licensed, and manufactured by Scientific Compliance (Atlanta, Ga.), and can be simply integrated into a range of easily removable orthodontic products (Figure 1). This Smart technology is only possible due to huge decrease in electronic element dimensions and power usage.[9]

## 5. Precision Biomedicine in Orthodontics

Ongoing basic research in this field, potentially contribute to the emergence of pharmacological and biological orthodontic procedures for usual routine practice, such as speeding orthodontic tooth movement (OTM), lowering treatment periods, enhancing tooth anchoring or holding, and skeletal growth modifications.


**Fig. 1:** A minuscule microcontroller and various ultra-small devices for tracking time, checking the environment, and keeping data make up the super smart retainer environmental microsensor, which is firmly and securely enclosed within an unit shorter than a penny. Under this instance, the microsensor is contained in an acrylic hawley-pattern retainer. It can also be incorporated using a clear thermoplastic retainer.

Whereas the development in bio-rational therapeutic approaches for tooth movement and craniofacial growth continues, recent techniques indirectly regulate biologic activities which help to amplify tooth movement that have started gaining some appreciation in the market as a result of corroborated and often when unverifiable allegations of their efficacy. The next sections examine both existing and prospective methods for controlling tooth movement as well as craniofacial growth and development.[10]

## 6. Regulation of Tooth Movements with Addon Biologic, Mechanical, and Surgical Supplements

Altering tooth movement, whether it is to expedite movement for accelerated orthodontic treatment or to decrease movement for anchorage or retention, includes various appliance-based variables such as force levels, types of forces, and contemporary wires and appliances. Physical/mechanical stimulation of teeth and bone, surgically facilitated orthodontic therapy (SFOT) that leads to RAP (regional acceleratory phenomenon), and localized release of bioactive messengers are all variables connected to appliances. Arch wires and materials, intermittent forces, and specialized brackets are some examples of appliance-based approaches. Physical/mechanical stimuli include vibrational forces, pulsed electromagnetic fields (PEMF), electrical current, and low-level lasers (e.g., Acceledent®, OrthoAccel Technologies; Houston, TX, USA). Surgery first orthodontics, corticotomy, dentoalveolar or periodontal, piezocision or minimally invasive corticotomy, and alveocentesis or micro-osteoperforations are some of the procedures used in SFOT and RAP (e.g. Propel Orthodontics, New York, NY). Biologic/pharmacologic-supplemented tooth movement involves the direct release of enzymes, drugs that simulate molecules, and genome therapy that uses scientifically documented methods to modify bone turnover.[11]

## 7. Skeletal Growth Biological Modulation

Skeletal malocclusions are mainly determined by the morphology and size of the maxilla and mandible. One or both jaws may be affected (maxillary hyper/hypoplasia or mandibular prognathism/retrognathism) leading to class II or III skeletal malocclusions. An experimental research found that changing osteoclasts during development induced differences in beak lengths in birds. Lower beak length increased while osteoclasts were blocked in culture with alendronate bisphosphonate, osteopontin, or an MMP-13 (matrix metalloproteinase-13) inhibitor, but decreased when osteoclasts were stimulated by injection of recombinant RANKL.[12]

The introduction of bio-pharmacologics to control normal skeletal growth and development throughout orthodontic treatment is likely several years away from practical implementation since we still do not have an uniform or universally recognized strategy of predicting or even quantifying skeletal growth. More research using animal model to explain the biomolecular basis of craniofacial growth, accompanied by human clinical testing trials, might potentially lead to the application of bio-pharmacologics to regulate craniofacial skeletal growth. Despite the fact that a variety of bio-pharmacologics have been found to speed up OTM (orthodontic tooth movement) and modulate face growth, additional study is needed to evaluate and select the best efficient drugs, as well as to find effective dose for optimal action and little systemic consequences. The development of "smart" drug release techniques is also essential for efficient dispersion, precisely controlled administration, and the right duration of action, possibly using nanotechnology and microprocessor release techniques.[13]

## 8. Precision Orthodontics in the Future

Given all of these advancements, what can we expect from precision orthodontics in the following decades? To deliver individual patient orthodontic treatments, computational imaging, 3D scanning, and bio technologies will be merged in the next phase. So, we still contemplate a method

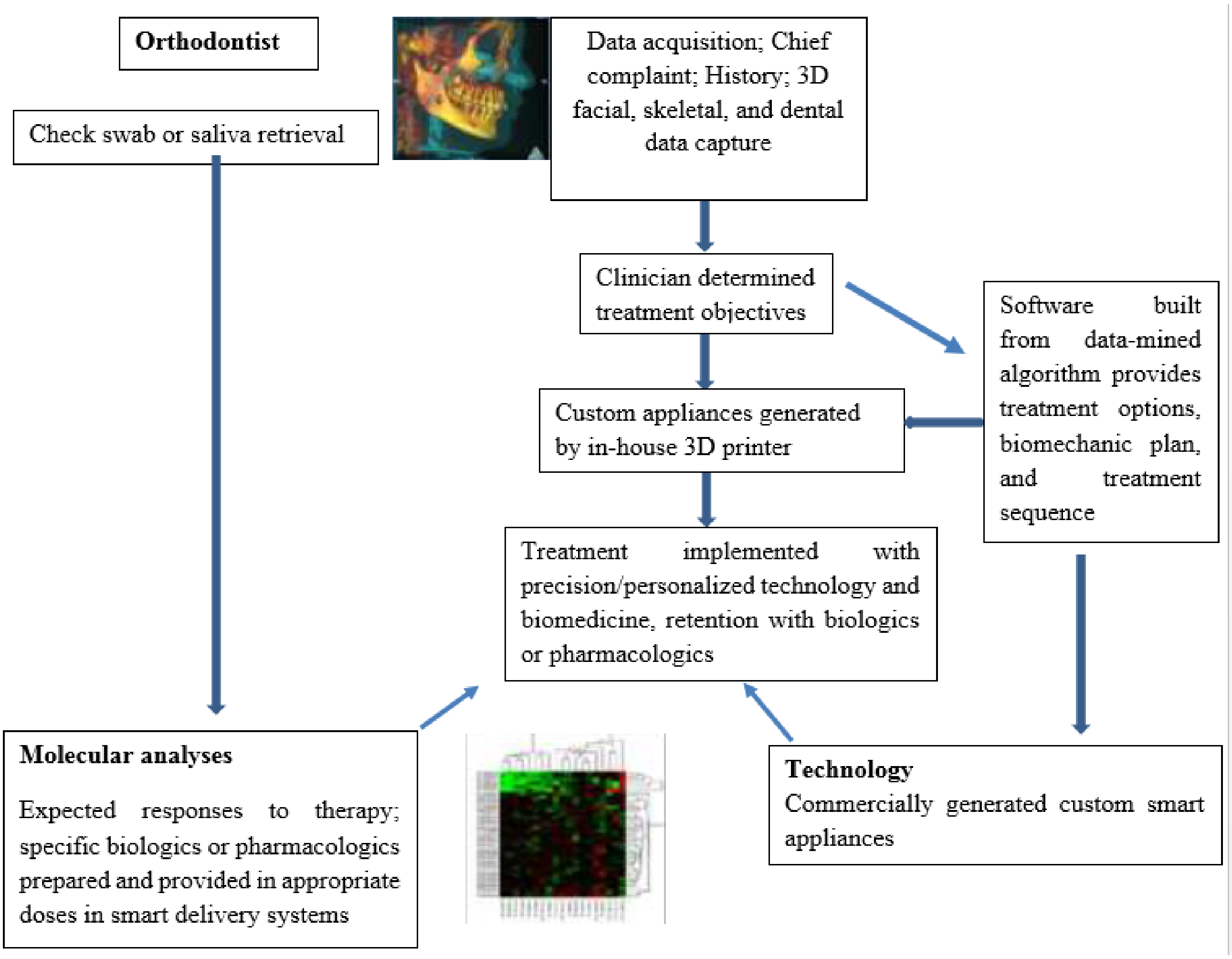


**Fig. 2:** A proposed vision for the integration of technology and biomedicine towards precision orthodontics.

that initiates with a specific diagnosis which is based on genomic and 3D morphologic traits, coupled with virtual simulation reinforced with custom-made appliances and treatment mechanics, and controlled with bio-pharmacologic agents that takes into consideration the patient's individual genetic traits and cellular variability.[14] (Figure 2)

## 9. Conclusion

Whereas there has been tremendous progress in each of major domains, more research is needed before effective therapies can be applied. Ethnic variety is lacking in normative libraries for phenotype comparison, and huge-scale sub-institutional investigations are essential to build thorough three - dimensional libraries. Systemic impacts and optimum doses efficiency are also needed to be discovered for bio-pharmacologic treatments that influence skeletal growth and tooth movements in animals. Interactions across metagenomic features and pharmacological action, and also drug optimizing effect by timed-release and localised administration via various vehicles, all need to be explored further. While we inch towards a more precise orthodontics, we hope to encounter more amalgamation in recent advances in digital technology and image analysis, biomodulation of tooth movement and skeletal growth, and patients's molecular genomic aspect to provide complete analysis, customised, and ideal orthodontic therapy.

## 10. Conflict of Interest

None.

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