Clinical Applications of Orthodontic Materials

First Edition

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Preface

Orthodontics, a specialized branch of dentistry focused on correcting misalignments of teeth and jaws, relies heavily on the properties and advancements of various materials to achieve optimal treatment outcomes.

In recent years, there has been significant progress in the development of orthodontic materials, driven by advancements in technology, biomaterials science, and the growing demand for more efficient and patient-friendly treatment options. These materials not only facilitate the mechanics of tooth movement but also contribute to the overall comfort and aesthetics of orthodontic appliances.

This book serves as a comprehensive guide for dental professionals, researchers, and students interested in understanding the characteristics, selection criteria, and clinical applications of orthodontic materials. Each chapter is meticulously crafted to provide a blend of theoretical knowledge and practical insights, supported by case studies and research findings from experts in the field. As the field of orthodontics continues to evolve, so do the materials and techniques that support it. This book aims to provide readers with a deeper understanding of the role that materials play in achieving successful orthodontic outcomes and will serve as a valuable resource in expanding knowledge and enhancing your clinical practice.

We extend our gratitude to all the contributors who have shared their expertise and experiences to make this book possible. This comprehensive exploration of orthodontic materials will inspire further advancements and innovations in the field, ultimately benefiting patients and practitioners alike.

Acknowledgements

We are thankful to Dr. Rahul Paul for his expertise and guidance on the clinical use and selection of orthodontic materials. His practical knowledge enriched the content of this section.

We gratefully acknowledge the following for their contributions to this section on dental materials in orthodontics:

- **Reviewers:** We extend our sincere gratitude to the reviewers who provided valuable feedback on the content related to dental materials. Their suggestions helped ensure the accuracy and clarity of the information presented.
- **Our colleagues and peers** whose insights and critiques have shaped this book into its final form.
- **Our families and friends** for their unwavering encouragement and understanding during the writing process.
- **Iterative International Publishers (IIP)** for their editorial and technical assistance

Thank you all for your invaluable contributions to this endeavor. Your efforts have truly made a difference in the field of dental materials

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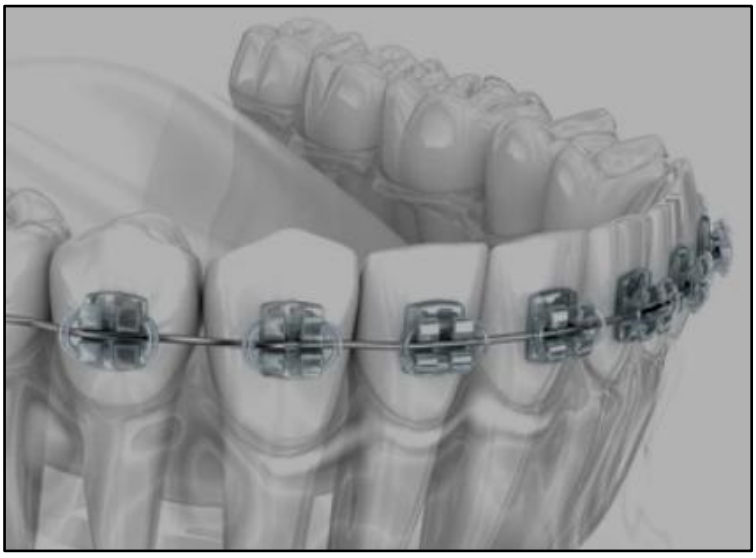
Introduction



Introduction to clinical applications in orthodontic materials typically serves as an brief overview that highlights the pivotal role of materials in orthodontic practice.

CHAPTER OUTLINE

- Importance of Orthodontic Materials
- Types of Orthodontic Materials
- Clinical Considerations

Men will never barter their souls or spill blood for it; yet this time-tested stainless steel, with the single exception of intrinsic value, offers more desirable characteristics to the fine-metal worker than do the precious metals themselves. The craftsman asks only that his material be chemically inert, naturally beautiful, strong yet amenable to his artistry; it is the buyer who measures precious metals by price.''[1]

Like metallurgy, dentistry has a long history of artistic creativity. From the Bronze Age to the Iron Age and the Industrial Revolution, professional ascent led to the development of modern metallography by Henry Clifton Sorby (1863–1887) and modern orthodontics by Edward Hartley Angle (1886–1930) in the latter half of the 19th century.[1]

Orthodontics, a specialized field within dentistry, focuses on rectifying tooth and jaw misalignments using a variety of materials for diagnosis, treatment, and protection. These materials include X-rays, diagnostic casts, retainers, and braces. The orthodontic process typically begins with X-rays and the creation of plaster casts to generate 3D models of the patient's teeth and jaws. X-rays help identify the root causes of misalignments, while casts aid in treatment planning. Once diagnosis is complete, orthodontists use various materials, such as stainless steel or ceramic, to fabricate orthodontic appliances like brackets. These brackets, crucial for holding the arch wire in place, allow for controlled tooth movement and alignment, leading to enhanced dental aesthetics and functionality. Overall, orthodontics utilizes a blend of materials and techniques to address misalignments effectively, ensuring optimal outcomes for patients.[2](Figure1.1)

Figure 1.1: Brackets with Archwire in Place

Orthodontic treatment employs a range of materials to address tooth and jaw misalignments. These materials include items like X-rays, diagnostic casts, braces, and retainers. Typically, treatment begins with X-rays and the creation of plaster casts to provide detailed models of the teeth and jaws[3]. This initial stage helps dentists identify the underlying issues causing misalignments and plan appropriate treatments. Following diagnosis, orthodontists use materials such as stainless steel or ceramic to create orthodontic appliances like brackets. These brackets play a vital role in treatment by holding the arch wire in place, allowing for controlled tooth movement. Elastic bands may also be used to aid in tooth

adjustment. At the end of treatment, retainers are often utilized to maintain the alignment of the teeth. Retainers can be made from various materials, including metal and acrylic. Additionally, orthodontists may employ adhesives, wax, and other materials throughout the treatment process to assist in guiding the teeth into their correct positions. Overall, the selection of orthodontic materials is tailored to each patient's unique needs, ensuring proper alignment of the teeth and jaws from diagnosis to completion of treatment.[4,5]

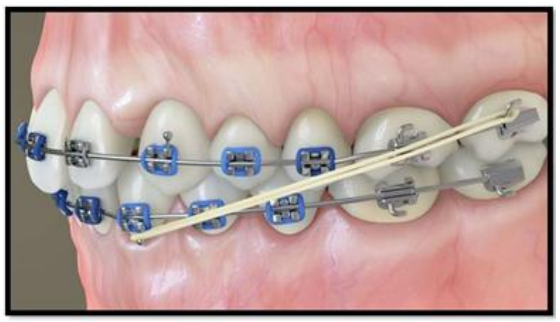


Figure 1.2: Brackets with Archwire and Elastics

Various orthodontic materials find application in clinical settings, including ligatures, intraoral buttons, and inter-arch elastics. Ligatures are small rubber ties linking the arch wire to the brackets, while intraoral buttons are utilized for attaching the arch wire to the brackets. Inter- arch elastics aid in shifting upper and lower teeth into the desired position. Alongside conventional braces components, modern orthodontic materials such as lingual braces, positioned behind the teeth, and clear aligners made from transparent plastic, offer advanced treatment options.[5]

The significance of orthodontic materials in clinical practice has surged, driven by technological and material science advancements leading to more efficient, comfortable, and aesthetically pleasing braces and aligners. These materials cater to a spectrum of orthodontic issues, ranging from simple teeth misalignment to intricate malocclusions.[6]

Orthodontic materials play a pivotal role across various clinical applications within dentistry, indispensable for the diagnosis, treatment, and maintenance of proper teeth and jaw alignment.

Here are some key clinical applications of orthodontic materials:

Braces (Fixed Orthodontic Appliances)

Braces serve as highly effective solutions for addressing various orthodontic concerns, including crowded teeth, spacing issues, overbites, underbites, and crossbites. They play a pivotal role in achieving a healthy and properly functioning bite while enhancing the aesthetic appeal of an individual's smile. Braces represent one of the most recognizable orthodontic interventions, comprising brackets typically crafted from stainless steel or ceramic materials, affixed to the teeth, and connected by arch wires,

often composed of nickel-titanium, threading through the brackets. Additionally, elastics, ligatures, and other adjunct components may be incorporated. By exerting gentle and meticulously controlled force, braces facilitate the gradual movement of misaligned teeth and jaws into their desired positions.

Figure 1.3: Metal Braces

Orthodontic Bands

Orthodontic bands, alternatively referred to as orthodontic rings or simply bands, are dental devices frequently employed in orthodontic interventions to facilitate the alignment of teeth and address diverse dental concerns. These bands consist of metal rings positioned around the molars, serving as stable foundations for braces or other orthodontic devices.[5]

Orthodontic Wires

These wires are available in a range of materials and dimensions, and they hold significant importance in directing the movement of teeth throughout rthodontic therapy.

Elastics (Rubber Bands)

Elastics are utilized to apply targeted forces to teeth, jaws, or braces, assisting in the correction of bite irregularities and alignment issues.

Retainers

Following orthodontic treatment, retainers are frequently employed to preserve the achieved outcomes by preventing teeth from reverting to their initial positions. Retainers are crafted from diverse materials, encompassing options such as metal and plastic.

Figure 1.4: Lingual Bonded Retainers

Space Maintainers

For the preservation of space for permanent teeth and to prevent overcrowding, Pediatric orthodontist use space maintainers.

Headgear

Headgear is an external orthodontic appliance affixed to braces, aimed at correcting bite

Chapter –2

Classification of Orthodontic Materials

CHAPTER OUTLINE

- Classification of various orthodontic materials
- According to their Structure
- According to their use in orthodontics
- Unique properties that make them suitable for different orthodontic appliances.

Chapter –3

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CHAPTER OUTLINE

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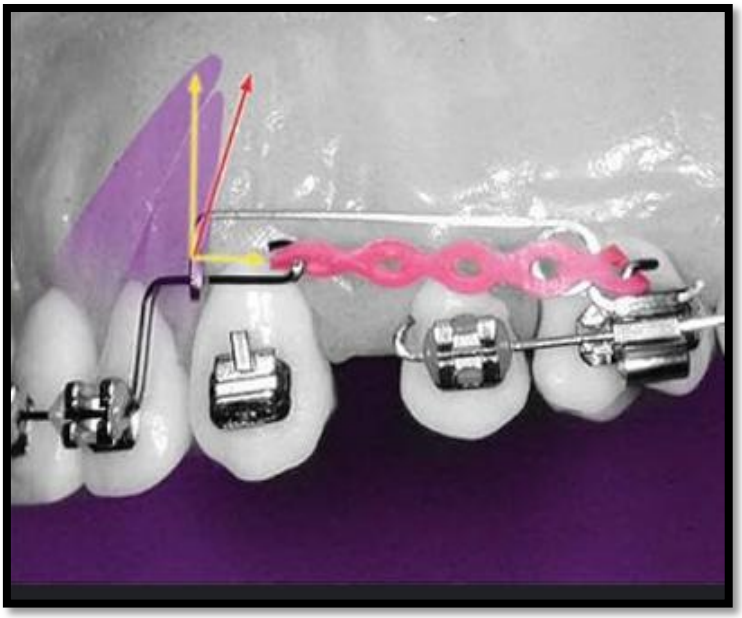
Adjunct /Auxiliary Force Delivery Systems



CHAPTER OUTLINE

- Introduction to adjunct force delivery systems
- Different force delivery systems
- Comparative studies of tooth movement
- Molar anchorage loss

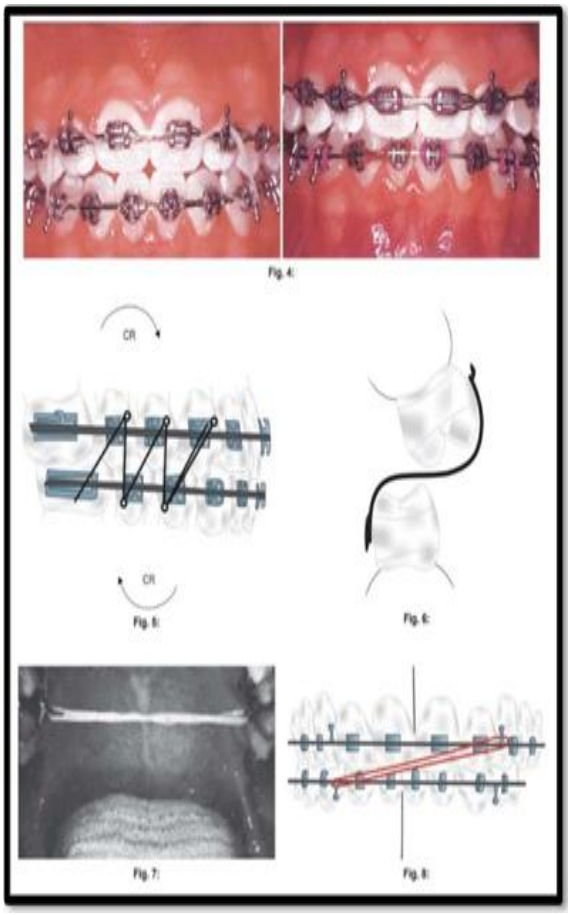


Figure 15.2: Zig Zag Elastics

Here are additional classifications of elastics:

- Crossbite Elastics (Force recommended: 5–7 oz)
- Cross Palate Elastics
- Diagonal Elastics (Midline Elastics) (Force used: 1½–2½ oz)

Open bite elastics, as illustrated in Figure 15.3 are employed to correct open bite malocclusions. They can be applied using various types:

- Box Elastics: These elastics apply a force of ¼" 6 oz or 3/16" 6 oz.
- Triangular Elastics: Utilized with a force of 1/8" 3 ½ oz.
- Vertical Elastics (Spaghetti): Applied with a force of 3 ½ oz.
- W and M Elastics: Exert a force of ¾" 2 oz.

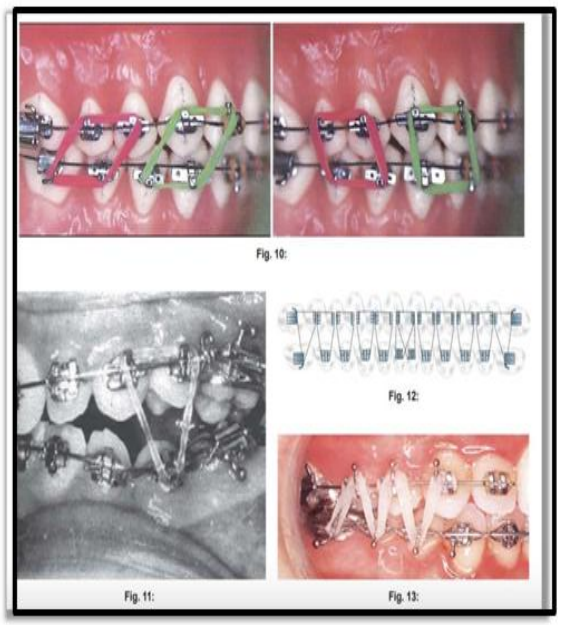


Figure 15.3: Open Bite Elastics

Lingual Elastics

By acting in opposition to or in addition to the buccal elastic force, these elastics increase the effectiveness of force distribution. By joining the lower molar's lingual hook to the upper arch wire's intermaxillary hook on the matching side, they can help straighten lower molars that are lingually pointed. Furthermore, provided that the arch wire is firmly attached back to the cuspid bracket, lingual elastics can be used in place of buccal elastics, such as Class I and Class II elastics [15]

and raising the retentive strength of orthodontic adhesive systems, improving the bonding process is still crucial, especially for molars that are subjected to high occlusal stresses [5,15]. Several in-vitro investigations have investigated various bonding strategies with the goal of decreasing molar bond failures. Clinical performance improved just little when the foil mesh base of the molar tube was sandblasted, according to Johnston and McSherry (1999).[55]. In an in-vitro study by *Pinzan- Vercelino et al.* (2011), the application of an additional adhesive layer at the occlusal molar/tube interface was found to increase shear bond strength[15] (Figure 17.4). Similarly, Nascimento et al. (2014) conducted an in-vivo study and reported that adding an adhesive layer at the molar/tube interface yielded higher bond strength compared to conventional direct bonding methods [12.]

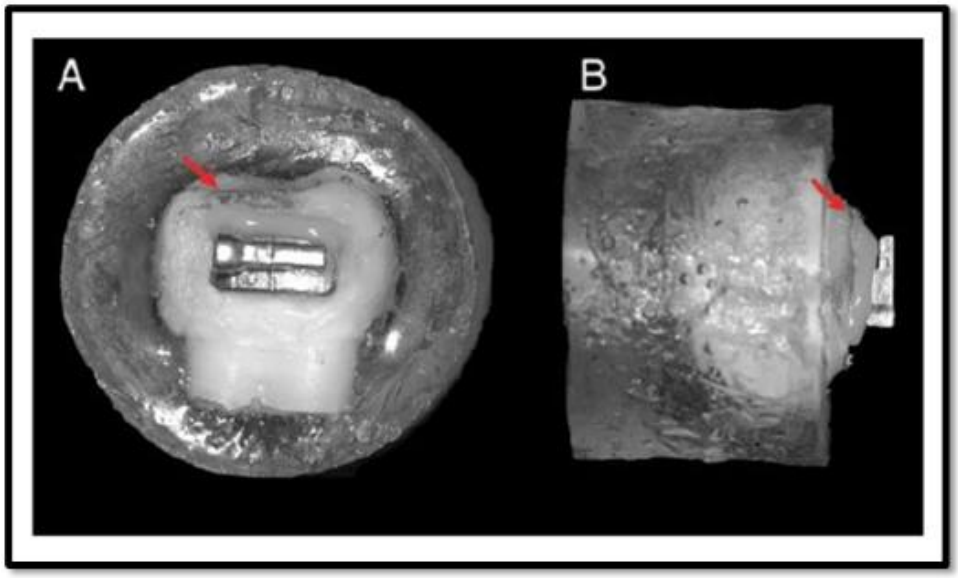


Figure: 17.4: Molar tube in buccal (A) and occlusal (B) views, bonded with an extra layer of resin (red arrow).

Orthodontists are beginning to recommend molar tubes because to improvements in enamel bonding procedures. High rates of molar tube failure formerly presented serious difficulties, resulting in longer treatment times and a rise in emergency visits. These problems have been resolved, though, by advancements in molar tube base design, adhesive choice, and bonding methods. The addition of undercuts and the welding of different-sized mesh wires into the molar tube base are two improvements to the base design. Because composite resins work better than other adhesives, they are still the recommended option. Additionally, bonding procedures have changed. Procedures like sandblasting, micro-abrasing enamel, and adding more adhesive layers at

insufficient length.

The self-ligating lingual bracket by Philippe.

Inspired by the Begg approach, Massimo Ronchin invented a self-ligating lingual bracket in 1994. The same company also created the Phillipe Self-Ligating Lingual Bracket, which lacked torque control but was mostly useful for alignment and leveling. Because there are no slots in these brackets, they can be bonded straight to the lingual tooth surface.

They make it easier to anticipate movements of both the first and second order. Additionally, a thin single-wing bracket is intended for lower incisors, while a three-wing bracket is offered for the connection of intermaxillary elastics and the application of third-order movements.[15]

Figure 18.3: Kelly Bracket: Horizontal Insertion Bracket

This bracket, which was initially a labial Unitek bracket but was modified for lingual use, has a twin design with two direct contact points between the bracket and wire, which makes it excellent at controlling rotations. Its adaption for lingual use, more than any particular technique, is credited with its efficiency in rotation control.

Figure 18.4: Kurz Lingual Bracket

The slot size available for these brackets is 0.022 inches. With their large hooks and rounded face shapes, they make it easier to attach springs and use power chains. Furthermore, the bracket's larger surface area facilitates double overtying. The broad bracket base improves bonding, while the horizontal groove makes it simpler to express torque control.

Figure 18.5: In –Ovation L Bracket from Gac

tooth, and the bracket slot lines up with the machine. This makes it possible to install brackets with access arch wire slots that are either vertical or horizontal. The lack of a necessity for a model tooth configuration is one big benefit. Nonetheless, the difficulty of controlling the slot machine's many components is a disadvantage.

Figure 18.6: Lingual Bracket Jig

The Jig for Lingual Brackets

The lingual bracket jig, created by Geron, makes it easier to position brackets both directly and indirectly. A set of six jigs for maxillary anterior teeth, a universal jig for posterior teeth, and a ruler are all included in this system. These jigs are used to transfer the Andrews labial bracket prescription to the lingual surface. An occlusal stop is used to measure the distance of the bracket from the incisal edge. The Lingual Bracket Jig is also used for direct bonding of brackets onto the lingual surface.

Hybrid Core System

The main emphasis in this approach is on moving brackets. With the introduction of the Hybrid Core System, Matsuno combined composite resin and silicone to create an indirect transfer tray. The bracket is covered with silicone during tray manufacturing, followed by composite resin. This combination makes it easier to remove the silicone piece from the glued bracket and guarantees that the transfer tray is positioned steadily inside the mouth.

Streamlined Method

Figure 18.7: STB Bracket

With the Simplified approach, a bracket placement plier and basic tweezers are used to install STB brackets directly on the lingual surface of teeth. The anterior teeth's incisal edge must be kept 1.5 to 2 mm away from the brackets during placement. Giuseppe Scuzzo and Kyoto Takemoto of Japan invented the STB brackets, which are made up of a lingual straight wire bracket and an STB procedure.[21]

The Orapix System

The Orapix system is the most recent lingual orthodontic laboratory

to encourage anterior growth of the maxilla, aiming for comprehensive dental and skeletal alignment..[2]

MAD IV – Treatment for Open Bite Correction

1. It incorporates anterior magnets for attraction and posterior NeFeBo magnets for repulsion.
2. The repelling magnets exert a force of 300g.
3. The anterior magnets assist in aligning the mandible to a central midline position and promote anterior rotation of the mandible.

The Propellant Unilateral Magnetic Appliance (PUMA)

4. Developed by Chafe in 1995 for managing hemifacial microsomia.
5. Utilizes repelling Sm Co magnets within upper and lower acrylic bite blocks.
6. Mimics the effects of an autogenous costochondral graft.
7. Individuals with this condition experience inadequate development of facial structures and muscles on one side.

The Magnetic Twin Block (Clark, 1996)

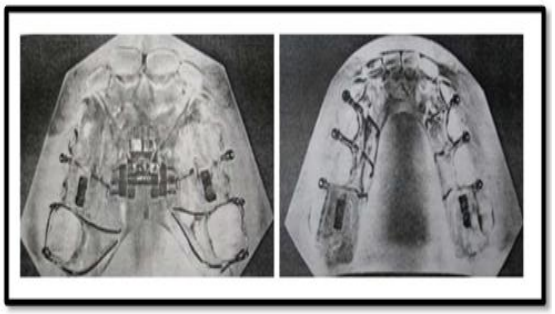


Figure 19.3: Magnetic Twin Block

Extrusion Method of Fractured Teeth

McCord and Harvie (1984) and Bondemark and Kurol (1997) employed magnets to facilitate the extrusion of teeth with fractures in their roots. This technique entailed the placement of attractive magnets, with one positioned at the root fragment and the other integrated into a removable appliance. Through the application of magnetic force, the tooth could be incrementally extruded to the intended location. After extrusion, the tooth could then undergo suitable restoration.[4]

Micro Magnetic Retainers: Springate & Sandler (1991) (Figure 20.4)

Figure 19.4: Micromagnets Retainers

Ne-Fe-Bo micromagnets can function as stationary retainers for individuals with midline diastema. These retainers provide benefits such as encouraging more natural tooth adjustments and supporting improved oral cleanliness in contrast to conventional fixed retainers

Chapter -20

Recent Advancements in Orthodontic Materials

CHAPTER OUTLINE

- Technological infusions
- Software applications
- Recent advances in brackets
- Rapid prototyping
- Recent advancements in different materials
- Imaging systems

"The materials used in orthodontics are not merely tools; they are the building blocks of transformation, shaping smiles and changing lives."

Dr. Harold Kesling

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Dr. Rahul Paul, *a teacher, a mentor and an orthodontist has been in the field for more than two decades. Presently, he is working as Principal and Heading the Department of Orthodontics and Dentofacial Orthopaedics in Inderprastha Dental College and Hospital, India.He is a specialised in aligners, myobraces, functional habit correction, lingual orthodontics and surgical orthodontics. He completed his B.D.S. and M.D.S. from ABSM Institute of Dental Sciences, Mangalore. With an experience over 20 years, he has numerous publications under his name in various national and international indexed journals. He is also part of various professional study groups and organizations. He has been awarded with various awards, which includes the Best IDA Thesis Award and Best outgoing Orthodontic student ICD Award (1999), Best Appreciation Award ICD (2007), Best principal Award 2022 (Global Educators Fraternity) and research excellence award (2023)*

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Dr. Ratika Sawhney *obtained her Bachelor of Dental Surgery (B.D.S) degree from IDST Institute Modinagar, Uttar Pradesh, where she secured a gold medal during her graduation. She also pursued Post Graduate Certificate in Endodontics, from GDC Amritsar. She further obtained a Diploma in Hospital Management from the National Institute of Health and Family Welfare, New Delhi. She served as a Junior Resident at Guru Tegh Bahadur Government Hospital, New Delhi. Currently, She is a Resident in the Department of Orthodontics and Dentofacial Orthopaedics at Inderprastha Dental College & Hospital,UP. She was awarded best paper at Dasana Dental Conference 2023.*

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