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# Comparative Evaluation of Mechanical, Optical and Surface Properties of Four Commercially Available Flexible Denture Base Materials on Water Absorption- An In Vitro Study

Debarghya Bhattacharyya<sup>1</sup>, Geeta Paul<sup>2</sup>, Mukesh Kumar Goyal<sup>3</sup>, Isha Saxena<sup>4</sup>, Supriya Shukla<sup>5</sup>, Surabhi Vashistha<sup>6</sup>

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## ABSTRACT

**Aim:** This study is oriented to evaluate the impact of water absorption on mechanical, optical, and surface properties of four commercially available flexible denture base resins. **Materials And Methods:** A total of 120 samples were prepared, with 24 samples for each of four resin types( Valplast, Lucitone FRS, Bre-Flex, and De-Flex) and 24 controls. Specimens followed ADA specification number 12 for flexural strength, surface hardness, surface roughness, and colour stability tests. Resin polymerization methods included auto-mix syringe injection for thermoplastics and compression moulding for PMMA. **Results:** Valplast exhibited the highest flexural strength consistently over time, followed by Lucitone FRS, PMMA, and De-Flex, with Bre-Flex showing the lowest resistance to bending. Valplast also maintained superior surface hardness compared to Lucitone FRS, which degraded over time. Valplast showed minimal surface roughness, enhancing aesthetics and comfort. Lucitone FRS displayed declining surface hardness, potentially impacting long-term durability with denture cleaners. Bre-Flex demonstrated exceptional colour stability, while Valplast also retained colour well. In contrast, De-Flex showed significant colour changes, raising durability concerns. **Conclusion:** Valplast demonstrated superior flexural strength, surface hardness, and surface roughness characteristics, making it highly suitable for long-term denture use. Bre-Flex excelled in colour stability but showed lower mechanical properties. Lucitone FRS exhibited good initial properties but suffered from reduced surface hardness over time. De-Flex's colour instability raises durability concerns. These findings highlight Valplast's overall favourable performance across multiple parameters crucial for denture base materials, emphasizing its potential for enhancing denture longevity and patient satisfaction.

**Key-Words:** Flexible Denture Base Material, Valplast, Lucitone FRS, Bre-Flex, De-Flex, Colour Stability, Flexural Strength

## INTRODUCTION

Edentulism significantly impacts an individual's quality of life by impairing chewing, speaking, and facial aesthetics. The prevalence of complete edentulism varies globally, with higher rates in countries like India, Mexico, and Russia. Factors contributing to tooth loss include smoking, poor diet, and inadequate dental care.<sup>1</sup> Denture base materials have evolved to improve functionality, aesthetics, and patient satisfaction. Polymethyl methacrylate (PMMA) has been the traditional choice for denture bases due to its ease of processing and cost-effectiveness<sup>2</sup>, but it has limitations such as volumetric shrinkage, water absorption, and low fracture resistance. Newer materials like flexible thermoplastic resins (e.g., Valplast and Bre-flex),

composite resins, and nanocomposites offer improved properties, such as better flexural strength, surface hardness, and colour stability. Flexible denture materials like Valplast provide enhanced comfort and durability, while composite resins reinforced with fibers offer increased fracture resistance and longevity. Maintaining denture hygiene is crucial to prevent infections and ensure the longevity of dentures. Chemical denture cleansers can affect the physical properties of denture materials, necessitating careful selection to avoid compromising the denture's integrity<sup>3</sup>. This study aims to evaluate and compare various properties of different denture base materials, focusing on the impact of denture cleansers on colour stability, surface roughness, hardness, and flexural strength. The research seeks to guide the selection of denture base materials and denture cleansers to optimize denture performance and longevity.

## MATERIALS AND METHODS

A total of 120 samples, comprising 24 samples of each four types of commercially available flexible denture base materials and 24 samples for a control group,

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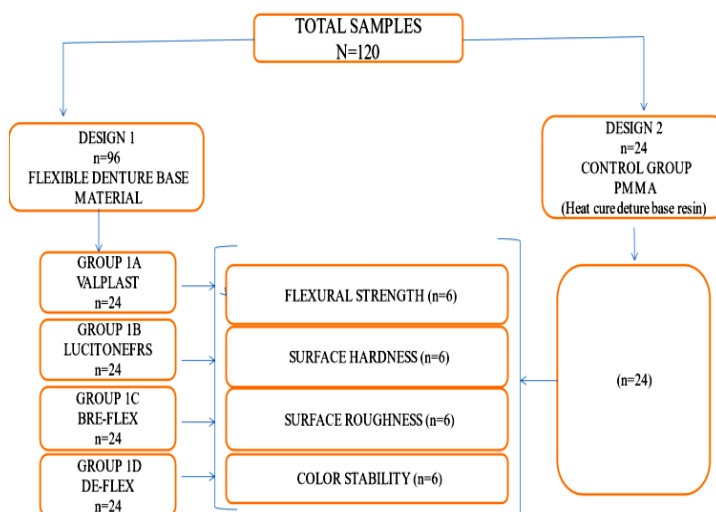
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were prepared and tested for flexural strength, surface properties, and colour stability. Groups were as, Group A: Valplast (Novoblast, USA), Group B: Lucitone FRS (Dentsply, Germany), Group C: Bre-flex (Bredent, Germany), Group D: De-flex (De-flex, United Kingdom) and a control group: PMMA heat cure denture base resin. [Figure-1] A total of 96 samples were prepared using injection moulding for the flexible denture base resins, following ADA specification no. 12, and 24 samples were prepared using compression moulding for the PMMA heat cure resin.

### Sample Size Selection

The size of the sample was determined using a statistical method known as Analysis of Variance, or ANOVA, in order to conduct comparisons among k means using a One-way ANOVA Pair wise, 2-Sided Equality approach. In broader terms, if we have k groups, there will be a total of  $K \equiv (k/2) = k(k-1)/2$  potential pairwise comparisons<sup>3</sup>. When we examine  $\tau \leq K$  of these pairwise comparisons, we are testing hypotheses of the form:  $H_0: \mu_A = \mu_B; H_1: \mu_A \neq \mu_B$  where  $\mu_A$  and  $\mu_B$  denote the means of two of the k groups, referred to as groups 'A' and 'B'. The necessary sample size for each of these  $\tau$  comparisons will be calculated, and the overall sample size required is determined by the largest among these. In the following formula, n represents the sample size in any one of these  $\tau$  comparisons, meaning there are n/2 individuals in group 'A' and n/2 individuals in group 'B'.

SAMPLES FLOW CHART



Surface treatment with 3.8% Sodium Perborate (w/v) denture chemical cleanser to check flexural strength, surface hardness, surface roughness and colour stability.

0 Day (N=120) > 1 Month (N=40) > 3 Months (N=40) > 6 Months (N=40)

For Testing of Samples in 1 Month, 3 Months, 6 Months-(n=2)

### Preparation of Flexible Denture Base Material Samples

A master mold from a stainless-steel block (65 x 10 x 3 mm and 1.5 mm x 50 mm) was used, in accordance in accordance with ADA specification no. 12. The process involved flask preparation and heating and injecting material. The lower flask section was coated with petroleum jelly and positioned flat. Type 4 gypsum was poured, followed by the upper flask section, forming the first pour. The flask was preheated for 15 minutes, silicone spray was applied to a filled cartridge, which was placed in the furnace. Post heating for 17 minutes, the flask was assembled and injected. The assembly was cooled, and the samples were refined and polished using acrylic techniques. [Figure-2]

### Preparation of PMMA Heat Cure Denture Base Resin Samples

Wax patterns were created using moulds of the specified dimensions. The polymerization process involved, wax Pattern investment, boil-out and cleaning, and acrylization. PMMA resin was mixed, kneaded, placed in the mold cavity, and pressurized. The curing cycle included an 8-hour water bath at 74°C followed by 1 hour at 100°C. The flask was cooled, and the specimens were finished and polished using acrylic burs, sandpaper, rubber points, and pumice. [Figure-3]

### Testing and Cleansing Protocol

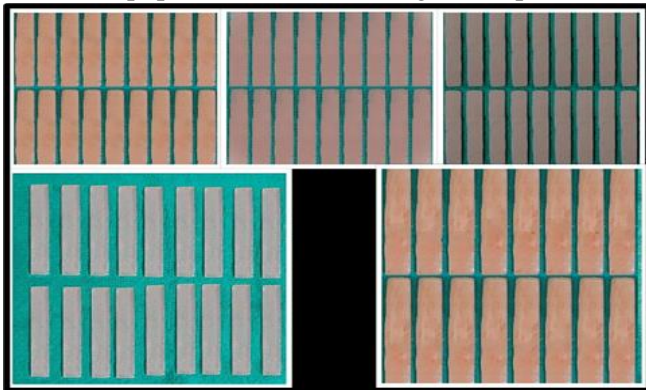
The samples were subjected to daily cleaning with a 3.8% sodium perborate solution for 10 minutes, rinsed, and stored at room temperature for six months. Physical, surface, and optical properties were evaluated at 1-month, 3-month, and 6-month intervals using, a universal testing machine, a Vickers hardness tester (for surface hardness), a surface profilometer (for surface roughness), and a spectrophotometer (for colour stability). [Figure-2,4] It aimed to assess and compare the performance of flexible denture base materials and PMMA over time, ensuring thorough evaluation and reliable results.



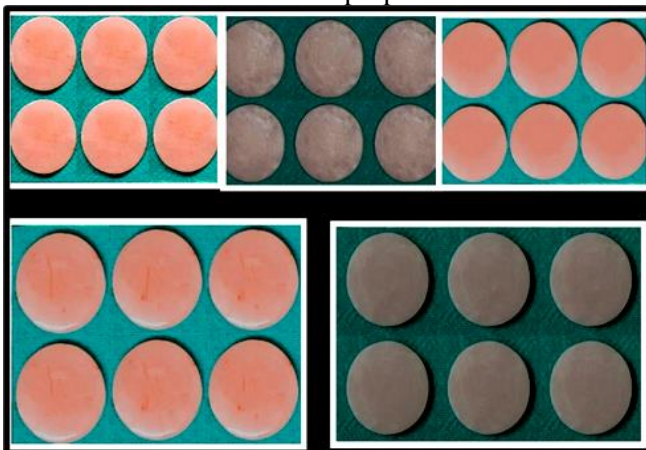
Fig 1: Materials used for fabrication of samples



**Fig 2:** Dies used for making samples and Equipments used for testing of samples



**Fig 3:** Fabricated samples for testing of mechanical and surface properties



**Fig 4:** Fabricated samples for testing of optical property

**RESULTS**

Flexural strength was evaluated across five material groups at 1, 3, and 6-month intervals. Valplast consistently exhibited the highest flexural strength at each interval, followed by Lucitone FRS, PMMA, De Flex, and Bre Flex, which consistently showed the lowest strength. Significant differences were observed among all five material groups at each time point, highlighting Valplast's superior mechanical performance over time compared to the other materials. [Table-1]

Surface hardness was assessed across five material groups at 1, 3, and 6-month intervals. After 1 month, Valplast exhibited the highest surface hardness, followed by De-flex, PMMA, Bre-Flex, and Lucitone FRS, which showed the lowest. Significant differences were noted among all five material groups. After 3 months, Valplast maintained the highest surface hardness, followed by PMMA, Bre-Flex, De-flex, and Lucitone FRS, with significant differences observed among the groups. Similarly, at 6 months, Valplast retained the highest surface hardness, followed by Bre-Flex, PMMA, De-flex, and Lucitone FRS, with significant differences noted among all material groups. [Table-2]

Surface roughness was assessed across five material groups at 1, 3, and 6-month intervals. After 1 month, the lowest surface roughness was observed in Valplast, followed by De-flex, Bre-flex, Lucitone FRS, and the highest in PMMA. A significant difference was noted among the five materials. This trend persisted at 3 and 6 months, with Valplast consistently having the least roughness and PMMA the most, with significant differences among all groups. [Table-3] After 1 month, the least colour change was observed in Bre-flex, followed by Valplast, Lucitone FRS, PMMA, and the highest in De-flex, with significant differences among the materials. This pattern remained consistent at 3 months. After 6 months, Bre Flex still had the least colour change, followed by Lucitone FRS, Valplast, PMMA, and the highest in De-flex, with significant differences among all groups throughout. [Table-4]

**Table: 1**

| Group               | 1 Month |      | 3 Months |      | 6 Months |      |
|---------------------|---------|------|----------|------|----------|------|
|                     | Mean    | SD   | Mean     | SD   | Mean     | SD   |
| <b>Valplast</b>     | 146.01  | 0.58 | 144.50   | 0.42 | 138.20   | 0.85 |
| <b>Lucitone FRS</b> | 140.57  | 0.10 | 137.72   | 0.79 | 130.11   | 0.16 |
| <b>Bre-Flex</b>     | 102.85  | 0.03 | 100.72   | 0.08 | 96.60    | 0.28 |
| <b>De-Flex</b>      | 120.53  | 0.18 | 116.20   | 0.06 | 112.17   | 0.09 |
| <b>PMMA</b>         | 129.86  | 0.47 | 125.27   | 0.49 | 122.03   | 0.49 |
| <b>p-value</b>      | <0.001* |      | <0.001*  |      | <0.001*  |      |

One-way ANOVA test; \* indicates a significant difference at p≤0.0

**Table: 2**

| Group               | 1 Month |      | 3 Months |      | 6 Months |      |
|---------------------|---------|------|----------|------|----------|------|
|                     | Mean    | SD   | Mean     | SD   | Mean     | SD   |
| <b>Valplast</b>     | 20.10   | 0.03 | 18.90    | 0.28 | 17.75    | 0.21 |
| <b>Lucitone FRS</b> | 16.45   | 0.21 | 15.70    | 0.14 | 14.65    | 0.07 |
| <b>Bre-Flex</b>     | 17.20   | 0.14 | 16.35    | 0.35 | 15.70    | 0.14 |
| <b>De-Flex</b>      | 18.25   | 0.21 | 16.10    | 0.14 | 14.95    | 0.21 |
| <b>PMMA</b>         | 17.25   | 0.07 | 16.65    | 0.07 | 15.55    | 0.07 |
| <b>p-value</b>      | <0.001* |      | <0.001*  |      | <0.001*  |      |

Table: 3

| Group        | 1 Month |      | 3 Months |      | 6 Months |      |
|--------------|---------|------|----------|------|----------|------|
|              | Mean    | SD   | Mean     | SD   | Mean     | SD   |
| Valplast     | 0.41    | 0.01 | 0.42     | 0.03 | 0.47     | 0.01 |
| Lucitone FRS | 0.53    | 0.01 | 0.57     | 0.01 | 0.63     | 0.01 |
| Bre-Flex     | 0.47    | 0.01 | 0.51     | 0.01 | 0.57     | 0.01 |
| De-Flex      | 0.42    | 0.01 | 0.45     | 0.01 | 0.49     | 0.01 |
| PMMA         | 1.16    | 0.01 | 1.21     | 0.01 | 1.27     | 0.01 |
| p-value      | <0.001* |      | <0.001*  |      | <0.001*  |      |

Table: 4

| Group        | 1 Month |      | 3 Months |      | 6 Months |      |
|--------------|---------|------|----------|------|----------|------|
|              | Mean    | SD   | Mean     | SD   | Mean     | SD   |
| Valplast     | 0.92    | 0.01 | 1.06     | 0.01 | 1.26     | 0.01 |
| Lucitone FRS | 1.11    | 0.01 | 1.17     | 0.01 | 1.23     | 0.01 |
| Bre-Flex     | 0.60    | 0.03 | 0.75     | 0.01 | 0.85     | 0.01 |
| De-Flex      | 1.50    | 0.03 | 1.65     | 0.01 | 1.72     | 0.03 |
| PMMA         | 1.30    | 0.00 | 1.40     | 0.07 | 1.60     | 0.07 |
| p-value      | <0.001* |      | <0.001*  |      | <0.001*  |      |

## DISCUSSION

Polymethyl-methacrylate (PMMA) is known for its rigidity, making it unsuitable for severe undercuts in denture applications. Studies show that adding carbon fibres to PMMA increases porosity and surface imperfections, compromising strength. Alternative materials with better flexibility<sup>4</sup>, such as thermoplastic materials (polyacetal or polyamide nylon), offer benefits like stability, resistance to heat, deformation, solvents, and wear, making them suitable for undercut areas. The study evaluated the long-term effects of a 3.8% sodium perborate denture cleanser on the flexural strength of four commercially available flexible denture base resins over six months<sup>5</sup>. Valplast exhibited the highest flexural strength consistently, followed by Lucitone FRS, PMMA, and De-flex, with Bre-flex showing the lowest. Flexural strength decreased over time for all materials, indicating that the cleaner may have a deteriorating effect. PMMA showed significant strength loss after three months, highlighting its vulnerability<sup>6,7</sup>. Valplast maintained superior surface hardness over time, suggesting high durability against the sodium perborate cleaner. In contrast, Lucitone FRS showed the lowest surface hardness, indicating susceptibility to deterioration. Changes in surface hardness over time varied among materials, with Valplast showing minimal changes and others like De-flex, PMMA, and Bre-flex exhibiting variable hardness trends<sup>8,5</sup>. Valplast consistently demonstrated the lowest surface roughness, indicating its ability to maintain a smooth surface despite exposure to cleaning agents<sup>9,10</sup>. PMMA showed the highest roughness, highlighting its limited capacity

to maintain a smooth surface over time. The findings emphasize the importance of material selection for long-term denture maintenance<sup>11</sup>. The study assessed colour changes over six months. Bre-flex exhibited the least colour change, indicating excellent colour stability, while De-flex showed the greatest discolouration. Valplast and Lucitone FRS displayed moderate colour stability, with PMMA showing significant colour change<sup>12</sup>. The temporal analysis revealed that some materials had improved colour stability over time, while others deteriorated. These findings have significant clinical implications. Valplast's high flexural strength, surface hardness, low roughness, and colour stability make it a suitable choice for long-term denture use<sup>13</sup>. In contrast, PMMA's vulnerability to strength loss, surface roughness, and colour change suggests it may not be ideal for flexible denture bases<sup>14</sup>. Dental professionals should consider these factors when recommending materials for dentures, ensuring a balance between favorable properties and long-term durability. The study's findings align with previous research indicating that nylon-based materials like Valplast offer superior flexibility and resistance compared to PMMA<sup>15,13</sup>. Studies have shown that thermoplastic materials generally exhibit better long-term performance in terms of mechanical properties, surface characteristics, and colour stability<sup>16,17</sup>. The results also highlight the impact of denture cleansers on material properties, underscoring the need for careful selection of both materials and cleaning agents to ensure optimal denture longevity and performance<sup>18</sup>. These findings have significant clinical implications for individuals who wear dentures and for dental professionals. Comprehending the precise behavior of materials when exposed to cleansers over a lengthy period of time might help in choosing suitable materials according to the requirements of patients and maintenance procedures. When advising patients on cleaning routines, clinicians should take into account the balance between the favorable characteristics of denture materials and their vulnerability to deterioration over time.

## CONCLUSION

The study concludes that Valplast is a promising material for dentures due to its high flexural strength, surface hardness, low roughness and in aspect of colour stability Bre-flex in superior to others, while PMMA commonly used, shows limitations in these areas, suggesting the need for alternative materials in specific denture applications. The choice of denture materials and cleansers should be tailored to balance durability, esthetics, and patient comfort for long-term satisfaction. In summary, further research on this topic could deepen our understanding of how water absorption affects flexible denture base materials across various dimensions

like impact strength, tensile strength, shear strength paving the way for advancements in dental material science and improved patient outcomes in prosthodontics.

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# Comparative evaluation of efficacy of xylitol containing toothpaste and fluoridated toothpaste in plaque removal in children with high caries index

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## ABSTRACT

**Aim:** To compare the efficacy of fluoridated toothpaste and xylitol containing toothpaste in plaque removal in children with high caries risk. **Materials and Methods:** For the present study 30 healthy children of aged 6-10 years to compare the efficacy of fluoridated toothpaste and xylitol containing toothpaste in plaque removal in children with high caries risk were taken. The children were randomly divided into 2 groups of 15 each. Group A – children using fluoridated toothpaste. Group B- children using xylitol containing toothpaste. At each interval (0,7,14 and 28 days) plaque indices were taken and efficacy was checked. **Results:** The overall evidence suggests that fluoridated toothpaste is more effective than xylitol toothpaste in improving oral health outcomes among children with a high caries index. **Conclusion:** Based on the data presented, both types of toothpastes (fluoridated, and xylitol-containing) were effective in improving oral hygiene and reducing plaque. However, there were differences in their effectiveness on gingival health.

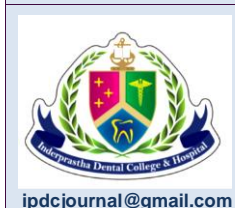
**Key-Words:** Fluoridated, High Caries Risk Plaque, Toothpaste, Xylitol

## INTRODUCTION

Dental caries and periodontal diseases are major public health concerns globally and have an adverse effect on the general health and quality of life of an individual. The dietary sugars and other fermentable carbohydrates affect the integrity of teeth, flow rate, pH, and composition of the saliva. The “dental plaque” is a biofilm of oral microbiota formed on a tooth surface as an embedded matrix of polymers derived from both host and bacterial origin. The dental plaque with adherent biofilm properties can lead to clinically specific dental caries, periodontal disease, and oral malodor.<sup>1</sup> Effective plaque removal is essential for daily oral care. Plaque is the primary cause of gum disease and tooth decay, two common dental problems. Dental plaque can be controlled with a combination of chemicals and mechanics treatment.<sup>1-4</sup> Manson outlines two primary methods for plaque eradication: chemical and mechanical. Of these approaches, mechanical plaque control through tooth brushing and other auxiliary devices is demonstrably more effective.

Rigorous mechanical cleaning with toothbrushes and other appropriate tools represents the most efficacious strategy for plaque control and calculus inhibition. However, it is important to acknowledge that tooth brushing alone is insufficient to completely prevent new plaque formation.<sup>5</sup> Dental plaque, initially a simple biofilm, grows more complex over time. While this healthy biofilm can protect against harmful bacteria, neglecting oral hygiene can lead to an imbalance, favoring the growth of disease-causing organisms. Even within a single species of bacteria, plaque can contain a range of behaviors, from active growth to a dormant state. "Ultimately an environmental shift occurs, resulting in gingival inflammation changes that favor periodontal pathogens."<sup>6</sup> The present investigation explores the potential influence of xylitol containing toothpaste and fluoridated toothpaste on plaque accumulation. A substantial body of prior research has focused on the development and evaluation of chemical agents capable of inhibiting or reducing plaque and calculus formation, Xylitol has garnered increasing interest within the field of dentistry due to its potential to promote oral health. Xylitol exhibits the unique characteristic of not being metabolized by *Streptococcus mutans* bacteria. This property is believed to contribute to the inhibition of *Streptococcus mutans* growth, thereby potentially reducing acid production and mitigating the development of cariogenic biofilms.<sup>7-9</sup>

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were prepared and tested for flexural strength, surface properties, and colour stability. Groups were as, Group A: Valplast (Novoblast, USA), Group B: Lucitone FRS (Dentsply, Germany), Group C: Bre-flex (Bredent, Germany), Group D: De-flex (De-flex, United Kingdom) and a control group: PMMA heat cure denture base resin. [Figure-1] A total of 96 samples were prepared using injection moulding for the flexible denture base resins, following ADA specification no. 12, and 24 samples were prepared using compression moulding for the PMMA heat cure resin.

## MATERIALS AND METHODS

### Study Design, Setting, and Ethical Considerations

A double-blind randomized controlled trial was conducted among the children reported to dental OPD of department of pediatric and preventive dentistry after securing Institutional ethical committee clearance. For the present study 30 healthy children of aged 6-10 years to compare the efficacy of fluoridated toothpaste and xylitol containing toothpaste in plaque removal in children with high caries risk. For the present study 30 healthy children of aged 6-10 years were selected. Before the commencement of the procedure and after explaining the procedure to the parents a written consent was taken from the parents. The children were randomly divided into 2 groups of 15 each. Group A – children using fluoridated toothpaste. Group B- children using xylitol containing toothpaste. Oral prophylaxis was performed followed by recording the indices. Sillness and Loe 1964 Plaque Index, Sillness and Loe 1963 gingival Index, oral hygiene index 1960 and gingival bleeding index was recorded. Each participant will be given the specific toothpaste according to the group they have been allocated. The patient was recalled after 7, 14 and 28 days and the similar procedure of recording of indices was performed.

### STATISTICAL ANALYSIS

Data was collected and analyzed using statistical package for social sciences (SPSS) version 27 The data was analyzed using t test and one way ANOVA to compare the efficacy of plaque removal in both toothpastes. The statistician sent the tables of both the study for the analysis for final results.

## RESULTS

The results are summarized in Table 1 to 3. Table 1 shows the efficacy of fluoridated toothpaste on OHI, PI, GI, GBI among children with high caries index. OHI and PI: There were significant improvements in both OHI (oral hygiene index) and PI (plaque index) over time.

The mean values decreased significantly from baseline to 7 days, 14 days, and 28 days, indicating that fluoridated toothpaste effectively reduced plaque and improved oral hygiene. GI and GBI: While there were changes in gingival index (GI) and gingival bleeding index (GBI), these changes were not statistically significant. This suggests that fluoridated toothpaste might have had a less pronounced effect on gingival health in this particular group of children. Based on the data presented, fluoridated toothpaste appears to be effective in reducing plaque and improving oral hygiene (as measured by OHI and PI) among children with a high caries index. However, its impact on gingival health (as measured by GI and GBI) was less clear in this study. Overall, the results of this study suggest that fluoridated toothpaste is a valuable tool for improving oral health in children with a high caries index, particularly in terms of reducing plaque and improving oral hygiene. Table 2 shows the efficacy of xylitol containing toothpaste on OHI, PI, GI, GBI among children with high caries index.

OHI, PI, GI, and GBI: There were significant improvements in all four oral health indicators (OHI, PI, GI, and GBI) over time. The mean values decreased significantly from baseline to 7 days, 14 days, and 28 days, indicating that xylitol-containing toothpaste effectively reduced plaque, improved oral hygiene, and positively impacted gingival health. Based on the data presented, xylitol-containing toothpaste appears to be highly effective in improving overall oral health among children with a high caries index. It demonstrated significant improvements in plaque reduction, oral hygiene, and gingival health. Overall, the results of this study strongly suggest that xylitol-containing toothpaste is a promising option for improving oral health in children with a high caries index. Table 3 shows the comparison between the efficacy of fluoridated and xylitol containing toothpaste on OHI, PI, GI, GBI among children with high caries index

- **OHI (Oral Hygiene Index):** Fluoridated toothpaste consistently showed lower OHI scores, especially in the 14-28 day time interval, indicating better oral hygiene compared to xylitol toothpaste.
- **PI (Plaque Index):** While both groups showed similar PI scores in the initial time intervals, fluoridated toothpaste had a significantly lower PI score at the 14-28 day mark, suggesting better plaque control.
- **GI (Gingival Index):** There was no significant difference in gingival health between the two groups, as measured by GI.
- **GBI (Gingival Bleeding Index):** Fluoridated toothpaste again demonstrated superior results, with significantly lower GBI scores, implying reduced gingival bleeding.

The overall evidence suggests that fluoridated toothpaste is more effective than xylitol toothpaste in improving oral



health outcomes among children with a high caries index. This is likely due to fluoride's well-established ability to strengthen tooth enamel and inhibit bacterial growth.

**Table 1:** Efficacy of Fluoridated toothpaste on OHI, PI, GI, GBI among children with high caries index

| Index                                    | Time Interval | Mean | Std. Deviation | F-value | p value      |
|--|---------------|------|----------------|---------|--------------|
| OHI                                      | Baseline      | 0.00 | 0.000          | 47.12   | <b>0.000</b> |
|  | 7 days        | 2.48 | 0.967          |         |              |
|  | 14 days       | 2.96 | 0.977          |         |              |
|  | 28 days       | 2.24 | 0.544          |         |              |
| PI                                       | Baseline      | 0.00 | 0.000          | 74.40   | <b>0.000</b> |
|  | 7 days        | 1.91 | 0.534          |         |              |
|  | 14 days       | 2.12 | 0.412          |         |              |
|  | 28 days       | 1.53 | 0.527          |         |              |
| GI                                       | Baseline      | 2.13 | 0.743          | 1.217   | 0.312        |
|  | 7 days        | 1.78 | 0.475          |         |              |
|  | 14 days       | 2.02 | 0.644          |         |              |
|  | 28 days       | 2.16 | 0.547          |         |              |
| GBI                                      | Baseline      | 1.92 | 0.502          | 1.589   | 0.202        |
|  | 7 days        | 2.12 | 0.672          |         |              |
|  | 14 days       | 1.80 | 0.763          |         |              |
|  | 28 days       | 1.67 | 0.406          |         |              |
| <b>p ≤ 0.05 – Significant, CI = 95 %</b> |               |      |                |         |              |

**Table 2:** Efficacy of xylitol containing toothpaste on OHI, PI, GI, GBI among children with high caries index

| Index                                    | Time Interval | Mean | Std. Deviation | F-value | p-value      |
|--|---------------|------|----------------|---------|--------------|
| OHI                                      | Baseline      | 0.00 | 0.000          | 44.78   | <b>0.000</b> |
|  | 7 days        | 2.87 | 1.114          |         |              |
|  | 14 days       | 2.43 | 0.652          |         |              |
|  | 28 days       | 2.16 | 0.699          |         |              |
| PI                                       | Baseline      | 0.00 | 0.000          | 55.37   | <b>0.000</b> |
|  | 7 days        | 1.85 | 0.495          |         |              |
|  | 14 days       | 1.72 | 0.623          |         |              |
|  | 28 days       | 1.82 | 0.511          |         |              |
| GI                                       | Baseline      | 1.73 | 0.593          | 7.376   | <b>0.000</b> |
|  | 7 days        | 2.30 | 0.452          |         |              |
|  | 14 days       | 1.48 | 0.506          |         |              |
|  | 28 days       | 1.53 | 0.617          |         |              |
| GBI                                      | Baseline      | 2.06 | 0.865          | 10.39   | <b>0.000</b> |
|  | 7 days        | 1.95 | 0.499          |         |              |
|  | 14 days       | 1.85 | 0.574          |         |              |
|  | 28 days       | 0.92 | 0.499          |         |              |
| <b>p ≤ 0.05 – Significant, CI = 95 %</b> |               |      |                |         |              |

## DISCUSSION

Oral hygiene is crucial for overall health, and plaque removal is a fundamental aspect of maintaining healthy teeth and gums. Various types of toothpaste, including fluoridated, and xylitol-containing, are available to aid in plaque removal. This discussion explores the comparative efficacy of these toothpastes in removing plaque. Fluoridated toothpastes are widely used and have been shown to be effective in preventing tooth decay. While they may not directly remove plaque, fluoride strengthens tooth enamel, making it more resistant to acid erosion caused by plaque. Xylitol is a sugar alcohol that can inhibit the growth of bacteria that contribute to plaque formation. Studies have shown that xylitol-containing toothpastes can effectively reduce plaque and improve oral health.<sup>1,8</sup> When both the toothpaste were compared it has been found that plaque removal efficacy of both types of toothpastes demonstrated effectiveness in reducing plaque. Numerous studies have consistently supported the efficacy of fluoride in preventing dental caries. A systematic review by the American Dental Association (ADA) concluded that fluoride toothpaste is effective in reducing the incidence of cavities in children and adults of all ages. While xylitol has shown promise in reducing plaque and preventing caries in some studies, its effectiveness may be more limited compared to fluoride.<sup>10-11</sup> However, the specific mechanisms by which they achieve this differ. Fluoridated toothpastes strengthen tooth enamel, and xylitol-containing toothpastes inhibit bacterial growth. While both toothpastes showed improvements in gingival health, xylitol-containing toothpastes demonstrated more significant effects. This suggests that these types of toothpastes may be particularly beneficial for individuals with gingivitis or other gum problems. The effectiveness of these toothpastes may vary depending on individual factors, such as oral health status, diet, and brushing technique.<sup>12</sup> Conflicting results have been reported as to xylitol-induced inhibition of mutans streptococci in saliva after toothpaste use [Mäkinen et al., 1985; Petersson et al., 1991; Svanberg and Birkhed, 1991; Twetman and Petersson, 1995]. Toothpastes containing either 20 or 9.9% xylitol reduced salivary levels of mutans streptococci but not plaque levels [Mäkinen et al., 1985; Svanberg and Birkhed, 1991], whereas xylitol (9.7%) [Twetman and Petersson, 1995] or xylitol (3%)-sorbitol(6%) [Petersson et al., 1991] toothpastes exerted no inhibition. The xylitol-induced inhibition of acid formation and growth of dental plaque bacteria has been explained by the so-called 'futile xylitol cycle' which involves depletion of phosphoenolpyruvate and ATP through the uptake of xylitol via induction of a fructose-specific phosphotransferase transport system [Trahan et al., 1985; Assev, 1987].<sup>12-15</sup> Both types of toothpastes

(fluoridated, and xylitol-containing) have shown effectiveness in plaque removal and improving oral health. However, the optimal choice may depend on individual needs and preferences. For individuals with specific oral health concerns, such as gingivitis or tooth decay, consulting with a dentist to determine the most suitable toothpaste is recommended. As gingival indices and plaque scores decreased from baseline, this suggests it may be beneficial to consider undertaking six month studies to investigate its longer term efficacy. Further studies are needed to evaluate the long-term effects of these toothpastes on oral health. Exploring the efficacy of toothpastes that combine multiple active ingredients, such as fluoride, and xylitol, could provide additional benefits. Developing personalized toothpaste recommendations based on individual oral health profiles could enhance the effectiveness of oral care.<sup>14,16</sup>

## CONCLUSION

Based on the data presented, both types of toothpastes (fluoridated, and xylitol-containing) were effective in improving oral hygiene and reducing plaque (OHI and PI). However, there were differences in their effectiveness on gingival health (GI and GBI). Xylitol-containing toothpaste appeared to be more effective in improving gingival health. Overall, the results of this study suggest that both types of toothpastes can be beneficial for improving oral health in children with a high caries index. However, the choice of toothpaste might depend on specific oral health needs, such as gingival health concerns and individuals choice.

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# Accuracy in Detection of Apical Patency Using Different 5th Generation Electronic Apex Locators: An In-Vitro Study

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## ABSTRACT

**Aim:** Among various techniques available, to determine the working length of the root canal, electronic apex locators help in overcoming the technical limitation of complex root canal anatomy and determining the apical constriction. The aim of this study was to analyse the importance of apical patency and its influence on the accuracy of 3 apex locators. **Materials and Methods:** Sixty intact extracted maxillary molars were collected and were divided into 3 groups (n = 20): Group 1 Propex II (Dentsply Sirona), Group 2 Propex Pixi (Dentsply Sirona) and Group 3 Woodpecker V (Woodpecker). Readings of the 3 apex locators were then compared with the actual microscopic working length. Data were statistically analyzed. **Results:** After using Chi – Square test, Propex II showed statistically significant difference in determination of apical patency followed by Propex Pixi and Woodpecker V.

**Conclusion:** Foramina patency could be considered as a prerequisite for a reliable working length determination with apex locators, all the test groups exhibited statistically significant differences, i.e. Propex II > Propex Pixi > Woodpecker V.

**Key-Words:** Apex locator, Apical Patency, Maxillary Molar

## INTRODUCTION

Successful root canal treatment depends on shaping of the whole length of the root canal space for meticulous cleaning and disinfection, followed by 3-dimensional obturation. This necessitates accurate determination of the apical constriction. The apical constriction, which is described as the minor apical diameter, is the point beyond which the periodontal tissues exist. Thus, maximizing the outcome of root canal treatment is closely related to limiting all the instruments, antimicrobial agents, and filling materials to the confines of the root canal system at the apical constriction.<sup>1</sup> One of the most essential tools for working length determination are the Electronic apex locator (EAL) because it overcomes the drawbacks of periapical radiography which demonstrates the 2-dimensional image. There has been a series of generations since the first launching of apex locator, which relied on direct electrical current and resistance. All the recent generations rely on alternating current of more than one frequency and on impedance rather than resistance. The main concept of all of these generations

is electrical conductivity between the attached file clip and the lip clip where the root dentin acts as an insulator and the periodontal ligament is the conductor. The electrical circuit is closed when the current passes through periodontal ligament to the oral mucosa and then to the lip clip.<sup>[2]</sup> A technique where the apical portion of the canal is maintained free of debris by recapitulation with a small file through the apical foramen is defined as apical patency.<sup>3</sup> The aim of the present study was to shed light on the importance of apical patency and its influence on the accuracy of 3 apex locators Propex II (Dentsply Sirona), Propex Pixi (Dentsply Sirona) and Woodpecker V (Woodpecker) among the many choices available. The null hypothesis to be tested was that there would be no statistically significant difference between the three tested groups. The alternate hypothesis was that there would be statistically significant difference between the three tested groups.

## MATERIALS AND METHODS

The master article along with the reference articles was sent to the statistician and sample size was calculated using G Power Software (Version 3.1.9.6) and set at 60 (n=20) based on the 95% power of the study, 5% type I error and effect size of 0.57. The descriptive statistics will include mean, standard deviation frequency and percentage. The level of the significance for the present study will be fixed at 5%. After securing Committee

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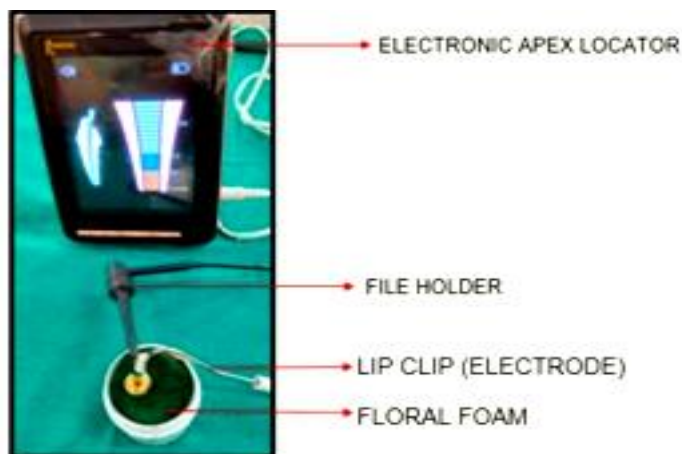
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**Fig 1A:** Sample Image



**Fig 1B:** Image Under Dental Operating Microscope



**Fig 2A:** Experimental Set-up

clearance, 60 human maxillary molars were taken for the study. Teeth with open apices, fractures and resorption were excluded. Figure 1A shows the sample with access cavity. Patency was confirmed, and then the canals were irrigated by 5 mL 2.5% NaOCl. K-file #10 was

advanced inside the root canal until it became visible at the apical foramen under a dental operating microscope at X25 (Figure 1B). The file was withdrawn, then the length was recorded. The mean of the obtained length was considered as the representative measurement of that sample. It was subtracted 0.5 mm from this measurement and then recorded it as actual working length (AWL). Figure 2 demonstrates a plastic mold with floral foam were used, within the molds in which the roots were embedded. 3 apex locators were calibrated to ensure proper function before measurements. Then inserted #15 K-file with silicone stopper inside the canal until the apex reading was reached. The extent of penetration inside the root canal of each sample was measured with each EAL and compared with the AWL. Canal blockage was intentionally induced Hedstrom stainless steel files (Mani) to create dentinal mud or plug. This dentinal plug was then forced to the apical foramen until the loss of canal patency was verified. During electronic measurement #10 K-file was inserted to the same previously recorded length for 3 apex locators, and then new readings were recorded. Positive difference meant that the measured length after blockage was longer than that before blockage, whereas negative measurements indicated shorter length, and 0.0 meant coincident measurements.



**Fig 2B:** Experimental Set-up



**Fig 2C:** Experimental Set-up

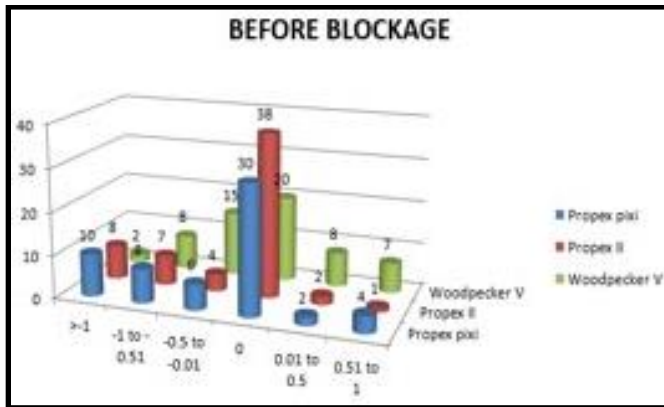
## RESULTS

After using Chi – Square test (Table 1), Propex II showed statistically significant difference in determination of apical patency followed by Propex Pixi and Woodpecker V as shown in Figure 3.

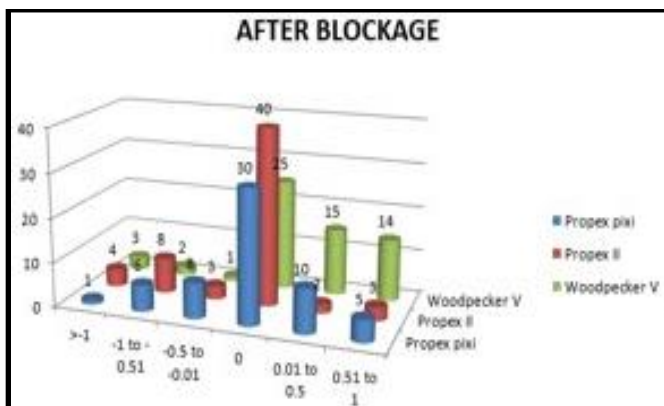
**Table 1**

| Before blockage | Distances in mm between file tip and the major foramen | Group                 |                     |                        | p-value |
|-----------------|--|-----------------------|---------------------|------------------------|---------|
|                 |  | Group 1 (Propex pixi) | Group 2 (Propex II) | Group 3 (Woodpecker V) |         |
|                 | 0 to -0.05   | 30 (50.0)             | 38 (63.3)           | 20 (33.3)              | 0.001 * |
| After Blockage  | 0 to -0.05   | 30 (50.0)             | 40 (66.7)           | 25 (41.7)              | 0.000 * |

**Figure 3A:** Graphical representation of the results



**Figure 3B:** Graphical representation of the results



## DISCUSSION

Working length determination using apex locators are at present the most pleasant chairside tool. As periapical radiograph is not an accurate tool for locating the working length, especially if the apical foramen opens laterally<sup>4</sup> in the present study the actual length was

determined with the dental operating microscope (x25). First Generation Electronic Apex Locators: they are based on resistance. They are unreliable as readings being significantly longer or shorter than the accepted working length. Second Generation Electronic Apex Locators are Impedance Based. The working principle is based on electrical impedance across the wall of the root canal due to the presence of transparent dentin. Third Generation Electronic Apex Locators are frequency dependent comparative impedance based. Identical to the 2nd generation EAL's but distance from the end of the canal are determined using multiple frequencies. Fourth Generation Electronic Apex Locators are based on ratio. These apex locators have built in electronic pulp tester and determine the impedance at five frequencies. The drawback with them is that they need to perform in relatively in partially dried canals or dry.<sup>5</sup> Fifth generation apex locators are based on dual frequency ratio which measures the capacitance and resistance of the circuit individually. They provide relevant readings in the presence of exudate and blood. The electrical circuit of EAL is considered complete when the electric current passes through the file attached to the clip, inside the root canal, then out of the apical constriction to the periodontium, and finally through the mucosa into the clip on the patient's lip. Sixth Generation Electronic Apex Locators are known as adaptive apex locators their efficacy in long term use yet to be established.<sup>6</sup> Inadequate irrigation and failure to establish apical patency accompanied with packing of the dentin chips in the apical part of the canal during root canal preparation causes apical canal blockage.<sup>7</sup> Extrusion of debris into the periapical tissue establishes the apical patency, with the ensuing flare-up or infection in case of necrotic pulp with contaminated debris using a large file. However, a small patency file such as #10 k file would not push the debris but rather pierces the accumulated debris in the canal to displace it and facilitates its removal with the help of irrigants.<sup>8</sup> According to a study done in 2013, Propex II apex locator was more accurate than the radiographic method in determining working length.<sup>9</sup> A study done in 2020 concluded that Apex ID, Root ZX mini, and Propex Pixi performed equally well in determining a position 0.5 mm short of the major foramen.<sup>10</sup> In this study, blockage was created by filing the middle and coronal thirds, followed by pushing and packing the cut debris apically to replicate the clinical condition of apical blockage. The flow of the current through the insulated file within the encased dentin and cementum inside the root canal would be disrupted.<sup>8</sup> The null hypothesis was rejected in the study as all the test groups exhibited statistically significant differences, i.e Propex II> Propex Pixi> Woodpecker V, and thus the alternate hypothesis was accepted.

## CONCLUSION

The study was performed to compare the accuracy of 3 different apex locators in human maxillary molars. Readings were taken and compared with microscopic working length. After which the apical blockage at the apical foramen was established. Variation in the readings of apex locators after blockage was compared with original readings before blockage to determine the measurement error. Under the limitations of this in-vitro study, the authors concluded that foraminal patency could be considered as a prerequisite for a reliable working length determination with apex locators, all the test groups exhibited statistically significant differences, i.e. Propex II > Propex Pixi > Woodpecker V.

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# A Radiographic Study of Mental Foramen

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## ABSTRACT

**Background:** The radiographic position of mental foramen is important to avoid the complications during the surgical procedures. The purpose of this study is to determine the most common location and appearance of mental foramen in general population of Ghaziabad district; Western Uttar Pradesh. **Aim:** To determine the most common location of mental foramen in the general population of Ghaziabad at different age groups and also to assess the appearance of mental foramen within the individuals in Panoramic radiograph taken among the general population of Ghaziabad. **Materials and Methods:** A total of 100 Panoramic radiographs were evaluated with regard to the position and appearance of the mental foramen among the general population of Ghaziabad at the various age group i.e. 20 – 29, 30 – 39, 40 – 49 and 50 – 59 Years. **Results and Observations:** In the present study of 100 patients, it was observed that the most common position of mental foramen is located in line with the second premolar (position 4) and the appearances separated type was reported equally in both males and female.

**Key-Words:** Mental Foramen, Panoramic, Appearance, Position

## INTRODUCTION

Anatomically, the mental foramen is the opening of the short mental canal, a branch of the mandibular canal. Mental foramen is frequently described as situated in the region of the second premolar in the fully developed mandible.<sup>1</sup> Although on most panoramic radiographs, the radiographic landmarks of the mental foramen can be observed, the appearance of these landmarks varies without any change of radiographic conditions.<sup>2</sup> The location of mental foramen varies among the different anatomic investigations performed. According to Tebo (1950) & Mastuda (1927) the mental foramen can be found in various locations ranging from the roots of the first premolar to the roots of the first molar. The location of the mental foramen differs not only in the mesio distal plane but also the inferio-superior plane and in its relation to the apices of the adjacent premolar teeth.<sup>3</sup> The determination of the location of mental foramen is of importance for differential diagnosis of the periapical Radiolucencies in the premolar area and for instance in the administration of local anesthesia for surgical, operative or diagnostic purpose and in endodontic treatment.<sup>4,5</sup> According to Yosue and Brooks (1989) the radiographic appearance of mental

foramen is of 4 types: 1- Continuous :-Mental foramen is in continuity with the mandibular foramen, 2-separated type : foramen is distinctly separated from the mandibular foramen, 3- Diffuse with distinct border of the foramen while the fourth group is unidentified type.<sup>2</sup> Hence, the need was felt to study the location of mental foramen through the panoramic radiography.

## AIMS AND OBJECTIVES

- To Determine the most common location of mental foramen in panoramic radiograph among the general population of Ghaziabad at different age groups.
- To Assess the appearance of mental foramen within the individuals in panoramic radiograph among the general population of Ghaziabad.

## Inclusion Criteria

Patients who reported to Department of Oral medicine and Radiology, Ghaziabad of age group between 20 years to 60 years of age were included in the study and was free of any pathology or deformities.

## Exclusion Criteria

- Presence of radiolucent pathological lesions in the lower jaw anywhere in the area extending from the right first molar to the left first molar and No visualization of the mental foramen bilaterally
- Incomplete eruption of permanent tooth.
- Patient below 19 years of age were excluded.

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- Presence of periodontal lesions.
- Patients with a history of orthodontic treatment.
- Presence of crowding and spacing in the lower arch.

## METHODOLOGY

A total of 100 subjects who were willing to participate after taking informed consent were considered for the study. The present study is IRB Approved and the relevant data was entered in the tabular form. The selected subjects were further categorized as male and females (Table - 1). The panoramic radiographs were taken by CS 8000C with high quality with respect to angulation and contrast.

According to **Yosue and Brooks (1989)<sup>2</sup>**, the Radiographic Appearance of mental foramen can be classified into four types (FIG 1).

- ✦ **A Continuous type** which shows continuity with the mandibular canal through the mental canal.
- ✦ **A Separated type** in which the foramen is distinctly separated from the mandibular canal.
- ✦ **A Diffuse type** in which the foramen has an indistinct border.
- ✦ **Unidentified type** in which the mental foramen cannot be identified on the panoramic radiographs under ordinary exposure and viewing conditions.

According to **HAGHANIFAR AND ROKOUEI (2009)<sup>5</sup>**, the Position of the mental foramen was recorded as follows (Fig 2):

- ✦ **Position 1:** Situated anterior to the first premolar
- ✦ **Position 2:** In line with the first premolar
- ✦ **Position 3:** Between the first and second premolar.
- ✦ **Position 4:** In line with second premolar
- ✦ **Position 5:** Between second premolar and first molar.
- ✦ **Position 6:** In line with first molar.

## RESULTS AND OBSERVATIONS

**Table 1:** Distribution of Males and Females

| Age Groups | Male | Females |
|------------|------|---------|
| 20-29      | 19   | 24      |
| 30-39      | 10   | 9       |
| 40- 49     | 9    | 10      |
| 50- 59     | 9    | 10      |
| Total      | 47   | 53      |

**Table 2:** Position of mental foramen Age-wise

| Age group Yrs | M/F     | Position 1 | Position 2 |     | Position 3 |   | Position 4 |  | Position 5 |     |
|---------------|---------|------------|------------|-----|------------|---|------------|--|------------|-----|
|               |         |            | L          | R   | L          | R |            |  | L          | R   |
| 20-29         | M(N=19) | NIL        |            | NIL | 5          | 0 | 12         |  | 1          |     |
|               | F(N=24) | NIL        | NIL        |     | 3          | 7 | 13         |  | 1          | NIL |
| 30-39         | M(N=10) | NIL        | NIL        | NIL | 3          | 3 | 4          |  | NIL        | NIL |
|               | F(N=19) | NIL        | NIL        |     | 3          | 4 | 2          |  | NIL        | NIL |
| 40-49         | M(N=9)  | NIL        | NIL        | NIL | 1          | 3 | 4          |  |            | NIL |
|               | F(N=10) | NIL        | NIL        | NIL | 4          | 2 | 3          |  |            | NIL |
| 50-59         | M(N=9)  | NIL        | 1          | NIL | 2          | 3 | 3          |  | NIL        | 1   |
|               | F(N=10) | NIL        | 1          | NIL | 4          | 3 | 2          |  | NIL        | NIL |
| Total         |         | 0%         | 3%         |     | 49%        |   | 43%        |  |            |     |

**Table 3:** Appearance of mental foramen Age wise

| Age Group (Yrs)   | Separated | Continuous | Diffuse | Unidentified |
|-------------------|-----------|------------|---------|--------------|
| 20-29<br>M(n=19)  | 14        | 05         | 02      | 01           |
| F(n= 24)          | 14        | 05         | 02      | Nil          |
| 30-39<br>M(n=10)  | 05        | 02         | 04      | Nil          |
| F (n = 9)         | 05        | 01         | 03      | Nil          |
| 40-49<br>M(n = 9) | 06        | 01         | 03      | Nil          |
| F(n=10)           | 06        | Nil        | 03      | Nil          |
| 50-60<br>M(n=9)   | 05        | Nil        | 03      | Nil          |
| F(n=10)           | 05        | Nil        | 03      | Nil          |
| Total (%)         | 60        | 13         | 26      | 01           |

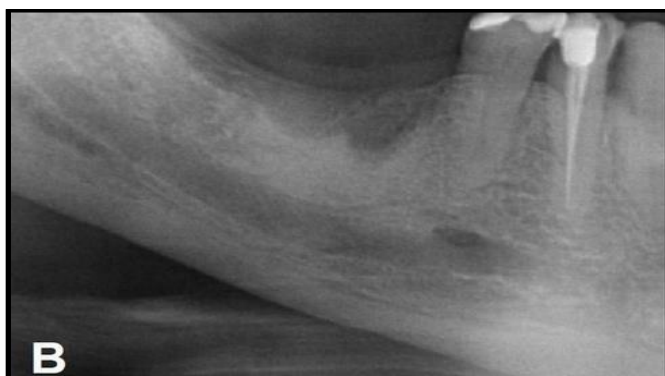
## DISCUSSION

Anatomically the mental foramen is the opening of short mental canal; a branch of mandibular canal. Although on most panoramic radiographs; the radiographic landmarks of mental foramina can be observed; the appearance and position of these radiographs varies without any change of radiographic condition.<sup>1,2</sup> In the present study, a series of 100 panoramic radiographs were taken and noted that the location of mental foramen varied widely; 49% of cases of mental foramen was located between the 1<sup>st</sup> and 2<sup>nd</sup> premolars and 46% was in line with the 2<sup>nd</sup> premolars. Thus, these two positions accounted for 89% of the cases. It was noted that within the age group of 20 -29 years;





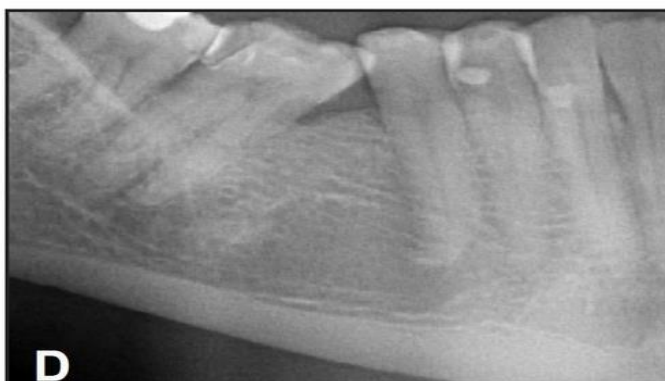
**Fig 1A:** Appearance of mental foramen (continuous)



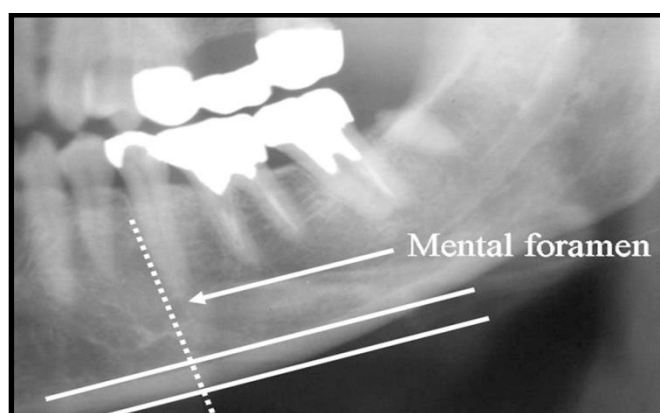
**Fig 1B:** Appearance of mental foramen (separated)



**Fig 1C:** Appearance of mental foramen (diffuse)



**Fig 1D:** Appearance of mental foramen (unidentified type)



**Fig 2:** Method used to determine the position of mental foramen

among males and females that there was no case found in position 1 (anterior to 1st premolar); position 2 was 5.2% in males group and 0% in female group; followed by the position 3 on left side is 26.4% of male group as compared to 12.5% of the same side among the females; the most common position is position 4 which is 63.15% among males compared to 54% in females. (Table 1) There was equal distribution of foramina on the left side and right side (5.2%) of position 5 among males and 4% of female group on left side. (Table 2). With in the age group of 30–39 years; there were no cases found with respect to position 1 and position 2 in both genders. The most common position is position 3 were males (60%) and females (77.8%) with more on the right side (44.4%) than left side. With in the age group of 40 – 49 years; there were no cases found with respect to position 1 and position 2 in both genders. The most common position is position 3 (60%) on the left side (40%) in females and in males it is 33% more on the right side. The more cases of location of mental foramina under position 4 (44%) and 5 (22%) were more in males as compared to females—22% and 0% respectively. With in the age group of 50–59 years; there was one case reported each in respect to position 2 in both the sexes, the commonest position being the position 3 (70%) on left side (40%) in females and whereas, in males (33%) on right side. A was done by Moiseiwtsch et al in 1998 stated that the most common location of mental foramen was between the two premolars.<sup>4</sup> These findings are consistent with the study results. A similar study was done by Haghanifar and Rokouei et al in 2009 stated that the 47.2% of the cases of mental foramen was located between the first and second premolar and in 46% was in line with the second premolar; thus, these two-position accounted for 93.2% of the cases.<sup>5</sup> In case of appearance of mental foramen; the most common one being the separated type cases reported equally in both males

(73%) and females (58%) between the age group of 20 – 29 years; The continuous, diffuse and un identifiedtypes are 26.3% ,10.5%and 5.2% among males and 20%, 8.3% and 0% among the females of 20–29 years age group respectively. Thus, the un identified type was found more in males as compared to females. The separated type cases reported equally in both males (50%) and females (55%), continuous, diffuse and un identified types are 10% ,40%and 0% among males and 11%, 50% and 0% among the females of 30–39 yrs. grouprespectively. (Table 3) A similar study was done by Yosue et al in 1989 reported the most frequent appearance was separated type (43%) followed by diffuse (24%), continuous (21%) and un identifiedtype (12%) which was confluent with present study.<sup>3</sup> The separated type reported equally in both males (66%) and females (60%)., Continuous, diffuse and un identified types are 11% ,33% and 0% among males and 0%, 30% and 0% among the females of 40–49 yrs age group respectively. The separated type in both males (55%) and females (50%), continuous, diffuse and unidentified types are 0%, 33%and 0% among males and 0%, 30% and 0% among the females of 50–59 yrs age group respectively.

## CONCLUSION

The most common position of mental foramen is between the two premolars (position 3) of left side among females and in line with the second premolar (position 4) among males. The mental foramina are usually symmetrically located on both sides. The appearance of mental foramen on panoramic radiographs can be divided into four types: Continuous, separated, diffuse and unidentified. The most frequent appearance of the mental foramen is the separated type. It is strongly suspected that sometimes the radiographic landmark of what is described as mental foramen is actually a section of the mental canal.

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# Evaluation of Platelet-Rich Fibrin Membrane on Wound Healing Post-Gingivectomy Procedure

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## ABSTRACT

**Background:** Gingival enlargement can be managed by scalpel gingivectomy. However, healing occurs by secondary intention. So, to promote healing Platelet rich fibrin (PRF) can be used as it is a rich source of growth factors. The present case series aims to evaluate the effect of PRF membrane on gingival wound healing by secondary intention. **Materials and Methods:** A total of 05 subjects, requiring gingivectomy, were selected. After gingivectomy, Platelet rich fibrin membrane was prepared in centrifugal machine then applied over the surgical site. Healing response was evaluated on 5<sup>th</sup>, 7<sup>th</sup> and 30<sup>th</sup> post-operative day. **Results:** On, 5<sup>th</sup> post-operative day, pain was mild in all the cases which completely subsided on 7<sup>th</sup> day post-operatively. Healing response was observed on 5<sup>th</sup> day post-operatively, showing almost complete epithelization with only few erythematous sites at gingival margin. However, on 30<sup>th</sup> post-operative day, all the sites were completely healed. **Conclusion:** It can be concluded that PRF may be safely used as a soft tissue dressing in open wound to achieve uneventful healing. However, future studies with larger sample size should be carried out to establish definitive result.

**Key-Words:** Gingival Enlargement, Gingivectomy, Platelet Rich Fibrin, Platelet Concentrates

## INTRODUCTION


Gingival enlargement is one of the common gingival diseases that primarily affects the appearance and functionality of teeth.<sup>1</sup> A number of etiologic causes and pathogenic processes, such as dental plaque, mouth breathing, hormone imbalances, and drugs, are linked to hyperplasia and/or overgrowth of the gingiva.<sup>2</sup> Restoring the anatomical and physiological condition of the periodontium is necessary for the long-term health and function.<sup>3</sup> Different gingivectomy methods can be used for the elimination of gingival overgrowth; of which the most common is scalpel.<sup>4</sup> Scalpel has advantages of being easy to be used, precise incision with well-defined margins, the healing is fast, and there is no lateral tissue damage.<sup>4</sup> While the disadvantage of scalpel are bleeding that result in inadequate visibility, post-operative discomfort to the patient and healing by secondary intention.<sup>5</sup> Different platelet concentrates are used as a therapeutic tools to improve tissue repair particularly in periodontal wound healing.<sup>6</sup> One of the platelet concentrate used nowadays is Platelet-rich fibrin (PRF) which was first.

developed in France for use in the field of oral and maxillofacial surgery by Choukroun et al. (2001).<sup>7</sup> PRF can be used to promote healing because platelets are a rich source of growth factors, including vascular endothelial growth factor (VEGF), (IGF-1), (PF-4), platelet-derived growth factor (PDGF), connective tissue growth factor (CTGF), epidermal growth factor (EGF), and transforming growth factor (TGF- $\beta$ , including  $\beta$ -1 and  $\beta$ -2-isomers).<sup>6</sup> Based on background information, improved wound healing on PRF application following gingivectomy can be anticipated, leading to a more favorable outcome. Patients who reported to Department of Oral medicine and Radiology of age group between 20 years to 60 years of age were included in the study and was free of any pathology or deformities.

## Case Series

Gingivectomy procedure was performed on 05 subjects with gingival enlargement grade  $\geq 2$  (Bokenkamp and Bohnhorst, 1994).<sup>8</sup> Oral hygiene measures were given to the patients. Patients with good oral hygiene compliance were taken for the surgery (Figure 1). Profound anaesthesia with 2% lignocaine HCL containing 1:80,000 adrenaline was obtained at surgical sites. The pockets were marked with a pocket marker to outline their course on each surface (Figure 2). The gingivectomy incision was taken using scalpel having Bard Parker blade no. 11/15 at 45 degree beveled to the

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**Fig 1:** Pre-operative view



**Fig 5:** PRF membrane applied over surgical site



**Fig 2:** Pocket marking with pocket marker



**Fig 6:** Healing on 5<sup>th</sup> post-operative day



**Fig 3:** Post-gingivectomy and gingivoplasty



**Fig 7:** Healing on 30<sup>th</sup> post-operative day



**Fig 4:** PRF Clot

tooth surface, started apical to the points marking the course of the pockets and was directed coronally to a point between the base of the pocket and the crest of the bone. The excised tissue was removed by curettes, area was cleaned and closely examined for any remnants of calculus or granulation tissue to be removed (Figure 3). Gingivoplasty was performed as indicated to create the physiologic gingival contours.

#### Preparation of PRF

After the recipient site preparation was completed, PRF preparation was done based on Dohan et al. (3000 rpm for

10 minutes) protocol. 10 ml of venous blood was drawn and placed in sterile tube without an anticoagulant. Tube was placed in the centrifugal machine and centrifuged immediately. The resultant product consisted of three layers. a) Platelet poor plasma supernatant b) Platelet rich fibrin in the middle layer c) Red blood cells at the bottom (Figure 4). After centrifugation, the PRF clot was obtained, separated from the **PRF clot** RBC base using scissors, and placed in PRF box. The PRF membrane was prepared by placing the PRF clot on the grill in the PRF box and covered with the compressor cover for 1 minutes to squeeze out the fluid. Then the membrane was taken up from the PRF box using tweezers and placed on the exposed gingival wound (Figure 5). Following this non-eugenol periodontal dressing (Coe-Pak) was applied. Post-operative instructions were given and patients were asked to avoid brushing at the surgical sites for at least 7 days. Antibiotic (amoxicillin with clavulanic acid 625 mg, BD) for five days, analgesic (diclofenac sodium and paracetamol tablet, SOS and 0.2% chlorhexidine gluconate mouthwash twice daily for 14 days were prescribed. Healing response was evaluated on 5<sup>th</sup>, 7<sup>th</sup> and 30<sup>th</sup> day post-operatively (Figure 6 and 7 respectively).

## DISCUSSION

In the present case series all the subjects stated that pain reduces progressively and on 5<sup>th</sup> post-operative day it was mild. As, after surgical gingivectomy, the gingival wound is large, having exposed raw connective tissue surface with exposed nerve endings that induce post-operative pain.<sup>9</sup> Bradykinin, a major plasma protease present during inflammation, increases vessel permeability and stimulates nerve endings to cause pain.<sup>9</sup> However, on telephonic communication, patient's pain was resolved completely in each subject at 7<sup>th</sup> post-operative day. Post-operative pain gradually decreases as the epithelization process begins over the connective tissue bed, which usually takes 5-14 days for complete epithelization.<sup>10</sup> Evaluation of healing response on 5<sup>th</sup> post-operative day showed almost complete epithelization on each subject except few erythematous areas at margins. This could be possibly explained by the effect of PRF as it forms a dense fibrin network with leukocytes, cytokines, structural glycoproteins and also growth factors that are released from 1<sup>st</sup> day which favor matrix remodeling and early epithelization during wound healing.<sup>11</sup>

On 30<sup>th</sup> post-operative day, complete healing was observed in each subject. The results were consistent with the case reported by Priyadarshini et al.<sup>12</sup> where PRF application was done after gingivectomy and uneventful healing was

found. Another study showed constant and steady release of six growth factors could be appreciated from PRF.<sup>13</sup> The slower release of growth factors over time is due to the ability of the fibrin matrix to store the proteins within its fibrin mesh as well as the cells capability to further release the growth factors into their surrounding microenvironment.<sup>14</sup> The dynamic VEGF is critical for neo-angiogenesis during the wound healing and also facilitate in maintaining the integrity of endothelial cell lining of the blood vessel.<sup>14</sup> The FGF and EGF are known to play an important role in the regulation of ectodermal and mesenchymal derived cell along being a potent chemotactic and mitogenic actions.<sup>15</sup> Thus, the diverse action of the growth factors forms a key player in wound healing and regeneration. The limitations of the present case series might be no histological analysis was done, which would have helped in more confirmatory results. For the future directions, larger sample size and use of more advanced form of platelet concentrate could enhance the soft tissue healing and less patient discomfort, for more accurate results,

## CONCLUSION

The results from the present cases signifies that the growth factors released from PRF at the sites might have some additional role and it can be safely concluded that PRF may be used in soft tissue wound dressing where exposed connective tissue is present to achieve uneventful healing. Further studies with more sample size should be carried out to evaluate the clinical effectiveness of PRF on healing after gingivectomy.

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# Transmasseteric Antero Parotid Approach for Open Reduction and Internal Fixation of Vertical Ramus Fracture: A Case Study

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## ABSTRACT

This case study explores the management of a 27-year-old male patient with a right parasymphysis fracture and a left vertical ramus fracture following a road traffic accident. Utilizing the transmasseteric anteroparotid approach for open reduction and internal fixation (ORIF), we discuss the clinical features, surgical techniques, and classification of ramus fractures. The results underscore the approach's effectiveness in achieving stable fixation and optimal functional recovery.

**Key-Words:** Ramus Fracture, Mandible Fracture, Transmassetric Approach, Anteroparotid Approach

## INTRODUCTION

Fractures of the mandible are commonly encountered by the oral and maxillofacial surgeon, and are in fact the third most common maxillofacial fracture after nasal bone and zygomatic bone fractures.<sup>1</sup> Mandibular fractures are common in trauma cases, and their management is essential for restoring function and aesthetics. Vertical ramus fractures are particularly challenging due to their location and potential complications, such as malocclusion and temporomandibular joint dysfunction. This report highlights the clinical presentation, surgical management, and outcomes of a vertical ramus fracture treated via a transmasseteric anteroparotid approach.

## Clinical Features

The patient, a 27-year-old male, presented to the Uttaranchal Dental and Medical Research Institute, Dehradun, on June 19, 2023, following a road traffic accident. Clinical examination revealed:

- Facial Edema: Significant swelling of the mandible, particularly on the left side leading to facial asymmetry.
- Malocclusion: The patient exhibited an anterior open bite and impaired occlusion.

- Tenderness and Crepitus: Palpation of the left ramus and right parasymphysis revealed tenderness and a palpable step deformity.
- Limited Mouth Opening: The patient reported difficulty in opening the mouth with mouth opening approximately 2 cm.
- Sublingual hematoma was present
- Mobility of fracture segments at right parasymphysis between 42 and 43
- Radiographic evaluation (OPG xray) confirmed a right parasymphysis fracture and a left vertical ramus fracture.

## Classification of Ramus Fractures

Type I: Vertical/oblique fracture line extending from the sigmoid notch to either the inferior border or angle of mandible.

Type II: Vertical/ oblique fracture line extending from coronoid process to either the inferior border or angle of mandible.

Type III: Horizontal fracture line extending from anterior border to posterior border of ramus of mandible.

Type IV: Oblique fracture line extending from posterior border of ramus to inferior border of mandible (separating the angle segment).

Type V: Comminuted fracture of ramus of mandible (may cause isolated fractures of the coronoid, condyle, and the angle of mandible).

The vertical ramus fracture in this case was classified as a displaced fracture due to the significant displacement observed during clinical and radiographic evaluation.<sup>2</sup>

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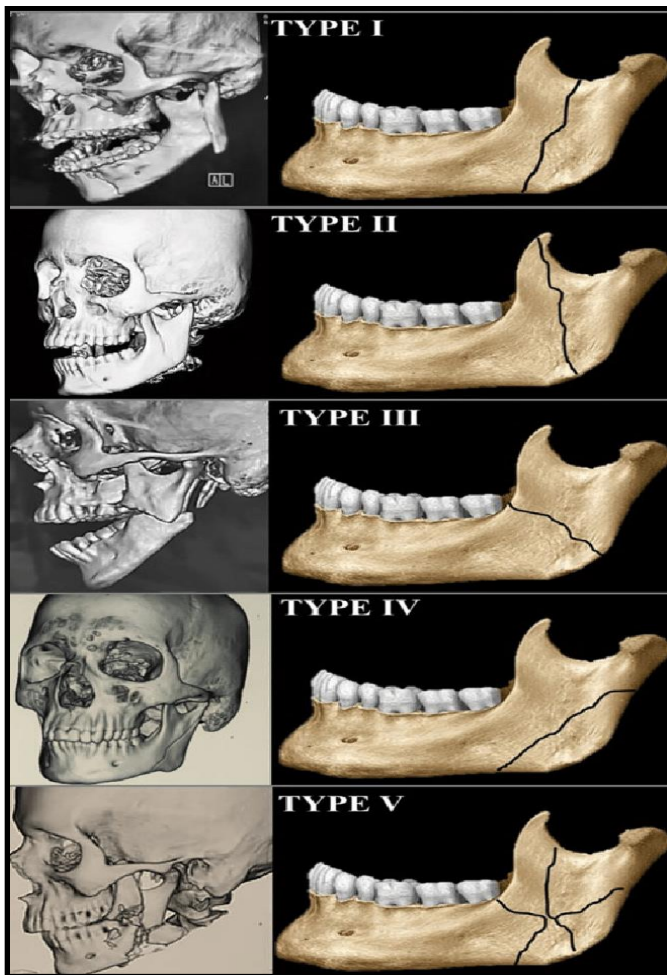


Fig 1: Pre-operative OPG xray



Fig 2: Pre-operative occlusion

## Surgical Procedure

The surgical intervention was performed under general anesthesia. The approach for each fracture was tailored to ensure optimal exposure and stabilization:

### 1. Right Parasymphysis Fracture:

- **Incision:** A vestibular incision was made, extending from the midline to the buccal vestibule.
- **Reduction and Fixation:** The fracture was reduced manually, IMF done with arch bars and fixation done with two titanium plates ie 2mm 4 holes with gap and 2mm 2 hole with gap secured using 2mm x 8mm screws.

### 2. Left Vertical Ramus Fracture:

- **Incision:** A modified retromandibular incision was employed to enhance access to the ramus without compromising the facial nerve.
- **Reduction and Fixation:** The fracture was stabilized using a 2mm 4-hole 3D titanium plate with 2mm x 10mm screws, providing stability to the vertical ramus. The transmasseteric anteroparotid approach facilitated access while minimizing soft tissue disruption.

Meticulous hemostasis was maintained in procedure, and wounds were closed in layers to promote healing.



Fig 3: Incision for mini retomandibular approach



Fig 4: Fixation with 3d plate





**Fig 5:** Post-op OPG xray

### Postoperative Care and Outcome

Postoperatively, the patient was monitored for complications, such as infection or nerve damage. Pain management included oral analgesics, and the patient was placed on a soft diet to facilitate healing. Follow-up appointments at two weeks and six weeks revealed:

- **Wound Healing:** No signs of infection; sutures were removed at two weeks.
- **Functional Recovery:** The patient demonstrated improved occlusion and mouth opening.
- **Radiographic Assessment:** Follow-up imaging confirmed proper alignment and healing of the fractures.



**Fig 6:** Post op healing

### DISCUSSION

The transmasseteric anteroparotid approach offers several advantages for the surgical management of vertical ramus fractures. This technique allows for direct visualization of the fracture site, facilitating accurate reduction and stable fixation. Studies suggest that this approach minimizes complications related to facial nerve injury and enhances postoperative recovery.<sup>3</sup> Proper classification of ramus fractures is crucial for

determining the appropriate surgical approach.<sup>4</sup> As noted, this case exemplifies the successful application of the transmasseteric approach in achieving satisfactory outcomes in a patient with a complex vertical ramus fracture.<sup>5</sup>

### CONCLUSION

The anteroparotid transmasseteric approach is a simple, direct approach to treating subcondylar fractures and ramus fracture. The successful management of a vertical ramus fracture using the transmasseteric anteroparotid approach demonstrates its effectiveness and reliability. This technique, combined with careful surgical planning and execution, can lead to excellent functional and aesthetic outcomes in patients with complex mandibular fractures.

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# Management of Class 2 Subdivision with Atypical Extraction and Unilateral Molar Distalisation: A Case Report

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## ABSTRACT

In the past few years, there has been an increase in the percentage of non-extraction cases in the average orthodontic practice, which now stands as high as 80%. Mid-arch extractions can compromise facial esthetics, especially in patients with concave profiles. The treatment plan must allow for post-treatment facial growth, including the tendency for the nose and chin of young adults to grow more forward than their lips. Decision of extraction of permanent teeth should be based on sound diagnosis, and it should be evidence based. This is a case report of young male patient who had moderate crowding, anterior crossbites, with midlines shift and an unaesthetic smile. This case was treated with unilateral first premolar extractions by using a individual T loop along with pre-adjusted Edgewise appliance and distalisation of molar by mini screws.

**Key-Words:** Atypical Extraction, Assymetrical Extraction, Unilateral Premolar Extraction, Unilateral Molar Distalisation

## INTRODUCTION

The extraction/non-extraction philosophy had received a great deal of consideration in orthodontics. The “no extractions under any circumstances” Angle’s philosophy had been conquered by “extractions when necessary” Case’s philosophy.<sup>1</sup> Nance in 1949 was one of the first to draw consideration to the extraction of second premolars in mild discrepancy cases.<sup>2</sup> Literature has stated that a nonextraction approach can be more esthetic in patients with mild or moderate bimaxillary protrusion.<sup>3</sup> Bimaxillary protrusion in adolescent patients has traditionally been treated by extracting the four first premolars and retracting most of the anterior teeth.<sup>4,5</sup> Although this approach is less complex than non-extraction treatment and can produce a good occlusal result, it also tends to retrude the lips and reduce the convexity of the face.<sup>6,7</sup> In the cases with severe incisor protrusion, facial convexity, lip incompetence, or crowding, premolar extractions may be unavoidable. In this case report, we describe the orthodontic management of a case who had moderate crowding, anterior cross bite, midlines shift, an unaesthetic smile and was treated with the unilateral extractions of first premolars.

## CASE REPORT

A 17 years-old post-pubertal male patient came to the clinic with the chief complaint of irregularly placed anterior teeth and unaesthetic smile. He was physically healthy and had no history of medical or dental trauma. No signs or symptoms of temporomandibular joint dysfunction or trauma were noted at the initial examination. Extra-orally he had a mesoprosopic facial form, mesomorphic body type with a straight facial profile, without any gross asymmetry. Intra-orally he had class I molar relation on left side and end on molar relation on right side and class I canine relation on right side, with an overjet of 1mm, and overbite of 4 mm, the maxillary left canine was in crossbite, lower arch form-square shaped. Upper midline is shifted to left by 1mm and lower midline is shifted to left by 3 mm. [Fig 1].

## Treatment Objectives

1. The treatment plan was to obtain space in both arches by the unilateral extraction of right first premolars. In upper arch space is required for assymetric crowding and in lower arch space is required to relieve the crowding.
2. The midlines had to be corrected.
3. Correction of anterior crossbite in relation to 13.
4. To achieve a stable functional occlusion with normal overjet and overbite, Class I canine and molar relationship on right side.
5. Maintaining Class I molar and canine relation on left side and pleasing profile.

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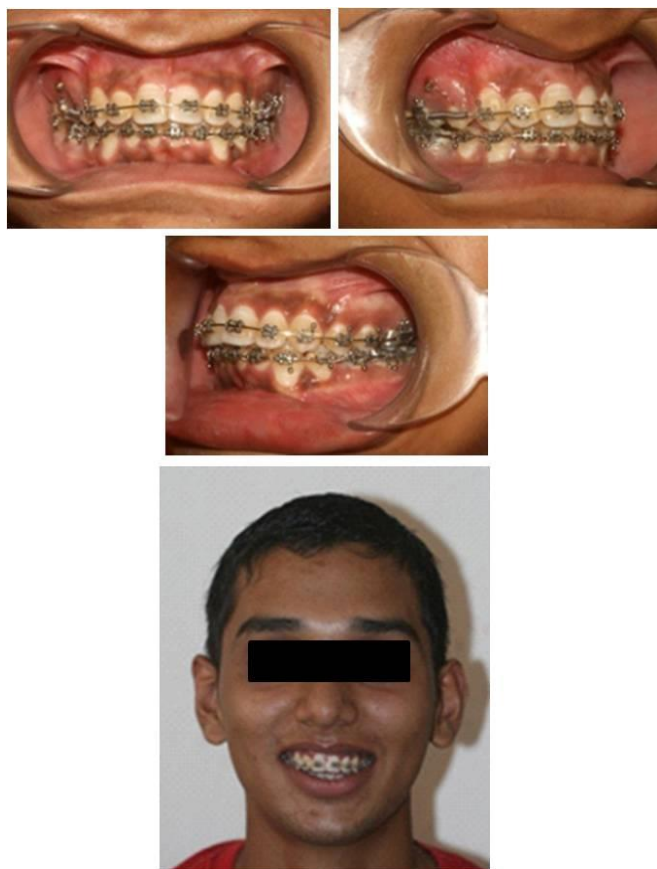


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**Fig 1:** Pre Treatment intraoral and extraoral photographs showing class 2 subdivision molar relation, crowding in both arches and midline deviated to left side



**Fig 2:** Mid treatment photographs: unilateral molar distalisation by mini implants between 26 and 25 to achieve class 1 molar relation on right side

## Treatment Progress

Initially, 24 and 34 were extracted and a MBT 0.022 bracket were bonded. Initial alignment wires, 0.014 NiTi were ligated. Ligation tie was given from 23 to 26 to aid in distalisation of canine for relieving of crowding. Simultaneously after decrowding, 0.017\*0.025 wire was ligated in both arches. Miniscrew (1.3\*8mm) was inserted in the maxilla in the region between 25 and 26. (fig2) Bracket on the right side premolar was removed and coil spring was tied to the mini screw for distalisation of the molar to correct the molar relation and midline. Total duration of the unilateral distalisation was 5 months. The case was debonded after 16 months of active treatment. Upper and lower Bonded Lingual Retainer from canine to first premolar were given. (Fig 3)



**Fig 3:** Post treatment extraoral and intraoral photographs showing class 1 molar and canine relation and coincident midline

## DISCUSSION

This case demonstrates the importance of identifying the specific area of arch asymmetry when initial good profile is present. Because the dental asymmetry for this patient was on the left side, it was appropriate to unilaterally extract in the maxillary arch to achieve canine symmetry and in the mandibular arch to relieve crowding. If the case had been treated with bilateral extractions, it was unlikely that the arch asymmetry would have been corrected thereby resulting in failure to center the dental midlines facially. Another advantage of this type of asymmetric extraction was to create the canine guidance

during lateral one movement of the mandible. The establishment of canine guidance is aimed in the orthodontic completion due to several factors: the strategic positioning of the canine in the arch; the favorable root anatomy, presence of a better crown root proportion; the presence of dense and compact bone around the root, which better tolerates the occlusal forces compared with the medullar bone of the posterior teeth; the sensorial pulse that activates less muscles when the canine teeth are in contact than when posterior teeth contact each other.<sup>8,9</sup> A study was done by Chen et al.<sup>10</sup> to clinically investigate the results of unilateral extraction in the treatment of moderate crowding cases. There is no significant difference in dental arch symmetry between unilateral extraction and bilateral extraction.

## CONCLUSION

Asymmetric extractions could simplify and facilitate orthodontic treatment and mechanics in some specific cases. As a result, first molars relationship could differ for right or left sides and this asymmetry would not bring functional or esthetics problems. However, the orthodontist must have total control of the mechanics used to achieve the best final results at the end of the treatment.

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# Anterior Crossbite Correction in Early Mixed Dentition Period Using Catlan's Appliance: A Case Report

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## ABSTRACT

Anterior crossbite poses a major esthetic and functional concern for parents during a child's developmental phase. Anterior crossbite rarely self-corrects, as the maxillary incisors are locked behind the mandibular incisors, leading to progressive malocclusion. Early intervention can help restore muscle balance and support proper occlusal development. Timely treatment can also prevent dysplastic growth of both skeletal and dentoalveolar components.<sup>18</sup> The Lower Inclined Bite Plane has been traditionally used to correct single or multiple anterior dental crossbites, provided sufficient space exists in the dental arch for labial movement of the upper incisors. This appliance works by utilizing the force generated by closing muscles and the inclined plane.

**Key-Words:** Anterior Crossbite, Mixed Dentition, Catlan's Appliance, Malocclusions, Orofacial Growth

## INTRODUCTION

Anterior crossbite presents a significant esthetic and functional concern for parents during a child's developmental phase. It is the responsibility of pediatric dentists or orthodontists to guide the developing dentition toward normalcy, aligning with the child's stage of orofacial growth and development.<sup>1</sup> The mixed dentition period provides an optimal window for occlusal guidance and interception of malocclusions.<sup>2</sup> Delayed treatment can lead to more complex procedures later.<sup>3</sup> Despite this, there are limited case reports on the use of Catlan's appliance for the treatment of anterior crossbite. This paper presents two cases where anterior dental crossbite was successfully corrected using a simple fixed Catlan's appliance. Graber defines crossbite as the abnormal positioning of one or more teeth, either lingually or labially, relative to their opposing teeth.<sup>4</sup> Anterior crossbite refers to the lingual displacement of maxillary anterior teeth relative to mandibular anterior teeth.<sup>5</sup> It can also be defined as the lingual positioning of upper primary or permanent anterior teeth in relation to the lower incisors. Severe cases of anterior crossbite, unlike posterior crossbite,

are typically left uncorrected until later stages of treatment or require surgical intervention. The early mixed dentition period offers an ideal opportunity to correct the bite using Catlan's appliance. To apply this appliance, it is important for the clinician to distinguish between crossbites of dental origin and those of skeletal origin.<sup>4,7-9</sup> Dental crossbite involves localized tipping of the teeth and does not affect the basal bone.<sup>10</sup> In simple anterior dental crossbite cases, the patient typically exhibits a normal skeletal pattern, with the problem limited to the axial inclination of the affected teeth.<sup>8</sup> As per Proffit, correcting anterior dental crossbite first requires creating sufficient space, followed by bringing the displaced teeth into proper occlusion.<sup>11</sup> Anterior dental crossbite is reported in approximately 4-5% of cases, usually becoming evident during the early mixed dentition phase.<sup>12,13</sup> Several factors contribute to the development of anterior crossbite, such as lingual eruption paths of the maxillary anterior incisors, repaired cleft lip, trauma to primary incisors, supernumerary anterior teeth, retained deciduous teeth, odontomas, incisor crowding, inadequate arch length, and upper lip biting habits.<sup>9,10,12-15</sup> If left untreated, anterior crossbite can result in abnormal enamel wear on the lower incisors, dental compensation of mandibular incisors, thinning of the labial alveolar plate, and gingival recession.<sup>4,7-9</sup> Prompt treatment of anterior dental crossbite is crucial to prevent mobility, fracture of the anterior teeth, periodontal problems, and temporomandibular joint issues.<sup>7,9,15,16</sup> The primary treatment goal is to tip the

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affected maxillary teeth labially until a stable overbite relationship is achieved.<sup>16</sup> Relapse is usually prevented by the normal overjet/overbite relationship that is established.<sup>17</sup> Various treatment options for correcting anterior crossbite include tongue blades, reversed stainless steel crowns, fixed acrylic inclined planes, bonded resin-composite slopes, removable acrylic appliances with finger springs, and the Bruckl appliance.<sup>9,10,14</sup> A 9-year-old female patient, accompanied by her parents, presented to the Department of Pediatric and Preventive Dentistry at the Government Dental Hospital, Raipur, with a complaint of a backwardly positioned upper left central incisor. A comprehensive clinical examination revealed the permanent maxillary left central incisor in crossbite. Based on clinical and radiographic assessments, the decision was made to fabricate an inclined plane. After informing the parents of the malocclusion, written consent was obtained. The crossbite was corrected within three weeks following the cementation of the Catlan's appliance. A 6-month recall showed a stable incisal relationship with no relapse. In this case, the patient was in the early mixed dentition stage, with class I molar and canine relationships. Sufficient mesiodistal width was present to allow labial movement of the maxillary tooth. Alginate impressions of both arches were taken, and an acrylic inclined plane was fabricated with a slope at a 45-degree angle to the tooth's long axis. The inclined plane was cemented onto the mandibular incisors and canines using zinc oxide eugenol cement. After the appliance was placed, the only contact point in occlusion was at the incisor region.



**Fig 1:** Intra oral view



**Fig 2:** Intra oral view of appliance

The patient was advised to maintain good oral hygiene, and weekly follow-ups were scheduled to monitor progress. Parents were informed that the child's bite might feel different initially, and a softer diet was recommended for the first few days after appliance

cementation. Once the correction was achieved, the Catlan's appliance was removed, the enamel surface polished, and topical fluoride (APF gel) applied. The appliance remained in place throughout the follow-up period without requiring recementation.

## DISCUSSION

Anterior crossbite rarely self-corrects, as the maxillary incisors are locked behind the mandibular incisors, leading to progressive malocclusion. Early intervention can help restore muscle balance and support proper occlusal development. Timely treatment can also prevent dysplastic growth of both skeletal and dentoalveolar components.<sup>18</sup> The Lower Inclined Bite Plane has been traditionally used to correct single or multiple anterior dental crossbites, provided sufficient space exists in the dental arch for labial movement of the upper incisors. This appliance works by utilizing the force generated by closing muscles and the inclined plane. However, one limitation of early treatment is the potential for two-phase orthodontic therapy, as predicting mandibular growth can be challenging.<sup>19</sup> The success of treatment with this appliance depends on case selection, which, according to Lee (1978), involves three key factors: adequate space in the arch to reposition the tooth, sufficient overbite to hold the tooth in position post-correction, and a class I molar relationship.<sup>7</sup> Factors such as crowding in the mandibular incisors, temporomandibular joint issues, and maxillary deficiency should be considered before selecting this treatment approach. The ideal age for correcting anterior dental crossbite is between 8 and 11 years, during which the tooth is still erupting and its root is forming. The child's age and motivation for treatment are crucial in determining the success of the intervention. Various treatment modalities for anterior dental crossbite correction in the early mixed dentition phase include tongue blade therapy<sup>20</sup>, reverse stainless steel crowns<sup>21</sup>, removable Hawley retainers with anterior Z-springs<sup>16</sup>, and bonded resin-composite slopes<sup>10</sup>. Tongue blade therapy requires patient cooperation and lacks precise control over the direction and amount of force applied. While reverse stainless steel crowns have been successful, they come with drawbacks, such as an unaesthetic appearance and limitations due to their pre-formed inclined slopes. Removable appliances also require cooperation from both the patient and parents for successful outcomes.<sup>22</sup> The Catlan's appliance (Lower Inclined Bite Plane) operates on Newton's third law of motion. The resin slope functions to tip the maxillary tooth labially while slightly tipping the mandibular tooth lingually.<sup>21</sup> This method is a safe, cost-effective, quick, and simple alternative for crossbite treatment. Its cost-effectiveness lies in its avoidance of fixed orthodontic procedures, and because it is cemented, it does not rely on patient compliance, does not interfere with growth, causes minimal discomfort, and requires few

dental visits.<sup>22</sup> However, the appliance can hinder speech, complicate chewing, and may result in anterior open bite if left cemented for more than six weeks.<sup>4</sup> Therefore, weekly follow-ups are essential to determine the appropriate timing for appliance removal and to avoid extended treatment durations.

## CONCLUSION

The cases presented demonstrate that Catlan's appliance is a viable and effective alternative for correcting anterior dental crossbite without the need for complex fixed orthodontic procedures. In this particular case, the crossbite was corrected within three weeks, with no adverse effects on the teeth or surrounding periodontal tissues. Emphasis should be placed on proper diagnosis and assessment of the malocclusion, taking into account the child's facial profile and the potential benefits of early treatment at this developmental stage. Further research is needed to compare this traditional method with other treatment approaches for anterior dental crossbite correction.

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## Recurrent Herpes Labialis: A Case Report

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### ABSTRACT

Herpes labialis remains exceptionally prevailing and is one of the most common human viral infections across the globe. Recurrent herpes labialis usually starts from the preliminary viral infection by herpes simplex virus type 1 (HSV-1) which consequently exhibits with or without symptoms. Reactivation of this virus is started by psychosocial reasons such as anxiety, febrile surroundings, ultraviolet light vulnerability, or specific dietary insufficiency. This virus infection is also categorized by continuous transitions between chronic-latent and acute-recurrent phases, permitting the virus to opportunistically avoid immunity and permit the spread to other susceptible hosts concurrently. According to WHO, an approximate 3.7 billion people under age 50 (67%) have HSV-1 infection globally. In the United States of America (USA), HSV-1 affects 57% to 80% of adults, while in Asia, the numbers are essentially high for adults (75%) especially those from low socioeconomic standings, and children (50%) due to epidemiological shifts, showing decreased seroprevalence in the young cohorts. It has been reported that recurrent herpes labialis (RHL) affects about one-third of the population in the USA and presents as inflamed/painful oral lesions with conditional distress. Some patients usually encounter up to six episodes per year which can be troublesome for patients and their families.

**Key-Words:** Herpes labialis, WHO, Seroprevalence, Oral Lesions, Herpes Simplex Virus

### INTRODUCTION

Herpes labialis, also known as the also known as fever blisters or cold sores, is a recurrent herpes simplex infection that usually affects the lips or the adjacent skin. It is one of the most prevalent and clinically obvious viral diseases presenting as bothersome, large, painful, and disfiguring lesions interfering with social activity and causing psychological problems<sup>1</sup>. It is one of most common infective vesiculo-ulcerative oral lesions with distressing and debilitating characteristics worldwide. It is contagious for the previously uninfected individuals and those with compromised immune systems such as HIV-infected individuals and those undergoing chemotherapy. Herpes labialis infection constitutes a serious risk to the dental team in the form of herpes whitlow and herpes keratitis during the treatment of patients with active lesions in the absence of proper infection control practices. From initial manifestation to complete healing between 7-10 days, occasionally 14 days, it has five clinical stages: Prodromal, blister, weeping, scabbing, and healing<sup>2</sup>. The clinical diagnosis of herpes labialis is based on case-specific historical findings, characteristic clinical appearance, and the location of the lesions.

### CASE REPORT

A 24-year old patient (Figure 1) who is a student, visited the department of Oral Medicine and Radiology with the chief complaint of irregular teeth since 6years and want to get them corrected. Patient gives a history of fever 2weeks ago. Patient has no tobacco habits. Patient brushes once daily with toothbrush and toothpaste. On examination plaque score of ++ and calculus of++ was noted and there was angel's class 2 division I malocclusion and anterior deepbite. On seeing, on to the left vermilion border of lip numerous vesicles were noticed. On inspection, it revealed minute vesicles (Figure 2) of size 1-4mm, 6to7 in number they appear red in colour and were seen on left vermilion border with proper outline, had clear demarcation of the vesicles. On palpation, it reveals that the vesicles were tender, no bleeding on scraping, non fluctuant and hard in palpation revealing, it was in healing phase. There were few differential diagnosis suggested for the case, which includes: Recurrent Herpes Labialis, Herpes Simplex Virus Type 2 (HSV-2) Infection, Aphthous Stomatitis, Contact Dermatitis, Impetigo, Angular Cheilitis, Erythema Multiforme and Candidiasis. But on the basis of history of fever and the recurrent appearance of vesicles whenever the patient experiences fever revealed that he must be suffering from recurrent herpes labialis. The treatment was planned for the patient by giving Acyclovir 5% ointment, to be applied on affected sites for 1week and recalled for the checkup. Further, follow-up was done in 4 weeks. During this visit, he reported a significant decrease in the frequency and

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severity of outbreaks, attributing this improvement to adherence to the treatment.



**Fig 1:** Extraoral picture of patient



**Fig 2:** Represents minute vesicles seen on left side of vermilion border

## DISCUSSION

Herpes simplex virus is contracted from infected saliva or other body fluids after an incubation period of approximately 4-7 days. Close contact with infected individuals, such as in play groups or sexually active persons predisposes to infection. HSV-1 can cause oral or oropharyngeal infection usually via infection from saliva, and is most frequent & at a lower age in lower socioeconomic groups. HSV-2 can cause severe oropharyngeal infection usually via orogenital or oroanal sexual contact<sup>3</sup>. Herpes simplex virus anogenital infection is contracted from infected semen, saliva or other body fluids. HSV-1 genital infection is usually less common & less severe than HSV-2 infection. Patients with immune defects are liable to severe and/or protracted HSV infections. Physical contact with an infected individual is the typical route of HSV inoculation for a seronegative individual who has not been previously exposed to the virus or possibly for someone with a low titer of protective antibody to HSV. The virus binds to the cell surface epithelium via heparan sulfate, followed by the sequential activation of specific genes during the lytic phase of infection. These genes include immediate early (IE) and early (E) genes

coding for regulatory proteins and for DNA replication, and late (L) genes coding for structural proteins.<sup>4</sup> During latency no infectious virus is produced; there is expression of early, but not late, genes; and there is no free virus. No major histocompatibility (MHC) antigens are expressed, so there is no T-cell response during latency. Some 50% of primary HSV infections are subclinical.

### The main features of clinical primary disease are:

- A. The mouth or oropharynx is sore.
- B. A single episode of oral vesicles which may be widespread, and break down to leave oral ulcers. These are initially pin point lesions but fuse to produce irregular painful ulcers.
- C. Acute generalized marginal gingivitis.
- D. Cervical lymph nodes may be enlarged & tender. Usually, several nodes in anterior triangle of the neck – especially the jugulo digastric nodes – are enlarged often bilaterally. Posterior triangle & nodes elsewhere are not enlarged, unless there are systemic complications or lesions in other sites.
- E. There is no hepato-splenomegaly unless there are systemic complications or lesions elsewhere. There is sometimes fever and /or malaise<sup>5</sup>.
- F. Diagnosis is largely clinical.

### Laboratory Investigations Include:

- A. Culture –takes days to give result.
- B. Electron microscopy –is not always available.
- C. Polymerase chain reaction detection of HSV-DNA is sensitive & Rapid but expensive.
- D. Immuno detection – conventional enzyme linked immuno sorbent assays (ELISA) for serum antibodies have poor sensitivity & specificity. While newer assays based on IgG1 HSV glycol proteins are comparable with western blot assays.
- E. A rising titre of serum antibodies is confirmatory but only gives the diagnosis retrospectively.
- F. Smears for viral damaged cells –routinely used.

### Clinical Features

Most lesion appear on the vermilion border of lip and surrounding skin, they are grey or white vesicles which rupture quickly leaving small red ulcerations, sometimes with erythematous halo on lip covered by bluish crust on lips. Size from 1-3mm to 2cm rarely causes disfigurement.

**Symptoms:** In either location is preceded by the tingling, burning sensation, feeling of tautness, swelling or slight soreness with subsequent development of vesicle.

**Signs:** It is accompanied by edema at the site of lesion followed by formation of clusters of small vesicles.

**Healing:** They gradually heal within 6-10 days and leave no scar.

**Complications:** They can lead to extragenital lesions, CNS complications and vaginal fungal infection.

### Incidence

It stands as one of most common infective vesiculo-

ulcerative oral lesions with distressing and debilitating characteristics worldwide. Herpes labialis is a commonly occurring ailment with reported prevalence of 15-32.9%<sup>6,7</sup>. It constitutes the third and fourth most prevalent oral mucosal lesion in children and youth in the USA<sup>8</sup> and in the adult population in Slovenia. Herpes labialis has been reported to constitute 0.58% of oral mucosal lesions in patients visiting a dental school in Southern India.<sup>9</sup>

### Diagnosis

1. **History:** Past history of contact with the person with the recurrent herpes labialis is helpful in making diagnosis.
2. **Typical Clinical Feature:** It is based on clinical presentation. Prodromal symptoms followed by the eruption of vesicles and marginal gingivitis.
3. **HSV** can be identified from scrapings from the base of lesion sealed on glass by giemsa and papanicolaou stain. Cytology shows intranuclear inclusions and multinucleated giant cells.
4. **Antibody Titer:** Antibodies seen in 1 week and raise to maximum by 3 weeks. Dark fluorescent is helpful than the routine cytology.

### Treatment Modalities

Some modalities on the treatment of herpes labialis:

#### a. Antiviral agents

Oral antiviral agents such as acyclovir, valacyclovir, and famciclovir are effective in treating herpes labialis. They can reduce the length of episodes and healing time. However, the best timing and duration of treatment is still unknown.

#### b. Photodynamic therapy

Antimicrobial photodynamic therapy (aPDT) can reduce the time it takes for herpes labialis lesions to heal and doesn't cause resistance.

#### c. Low-level laser therapy

A systematic review found that low-level laser therapy is generally superior to conventional treatment or placebo. However, more studies are needed to determine its effectiveness reliably.

#### d. Side effects

Side effects of oral antiviral medications include headache and nausea. Side effects of zinc oxide and glycerin cream include burning and itching. Side effects of zinc sulfate gel include dryness and a feeling of tightness.

#### e. Combination therapy

A combination of oral valacyclovir and topical clobetasol therapy is one of the most effective treatments for reducing healing time of the herpes labialis.

## CONCLUSION

Herpetic infections represent a reactivation of the herpes simplex virus, which is highly infectious to patients, their families, dentists and staff members. The diagnosis of these conditions usually is based on case-specific historical findings, the characteristic clinical appearance and the location of the lesions. Dentists often treat patients with a history of recurrent herpetic infections. Until the herpetic lesions are completely healed, the dental team should use management strategies to prevent spread of the virus, ensure adequate nutrition and maintain appropriate oral hygiene practices.

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# Artificial Intelligence– Ray of Hope

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## ABSTRACT

Artificial Intelligence (AI) technologies are having a profound impact across sectors such as healthcare, engineering, science, and smart cities. In healthcare, AI has shown great potential to enhance patient care and treatment outcomes while reducing the risk of human error.<sup>1</sup> Dentistry is undergoing a similar transformation, with AI being utilized for the diagnosis of dental diseases and providing treatment recommendations. Increasingly, dental professionals rely on AI for diagnosis, clinical decision-making, treatment planning, and prognosis prediction across ten dental specialties.<sup>2</sup> A key advantage of AI in dentistry is its ability to rapidly analyze large volumes of data with precision, providing valuable insights that support enhanced decision-making.<sup>3</sup> This paper aims to explore the advancements in AI algorithms frequently used in dentistry and evaluate their performance in diagnosis, clinical decision-making, treatment, and prognosis across ten dental specialties: dental public health, endodontics, oral and maxillofacial surgery, oral medicine and pathology, oral and maxillofacial radiology, orthodontics and dentofacial orthopedics, pediatric dentistry, periodontics, prosthodontics, and digital dentistry.<sup>4</sup>

**Key-Words:** Artificial Intelligence, Digital Dentistry, Dentistry, Dental Specialty

## INTRODUCTION

Artificial Intelligence (AI) refers to the ability of machines to perform tasks typically requiring human intelligence. AI has been adopted in various industries, including robotics, automotive, smart cities, and financial analysis. In healthcare and dentistry, AI plays a role in medical and dental imaging diagnostics, decision support, precision medicine, drug discovery, wearable technology, and robotic assistants.<sup>5</sup> In dentistry, AI helps alleviate clinicians' workloads by diagnosing diseases using multi-modal data, learning from various sources beyond human capabilities.<sup>6</sup> For example, AI can analyze fundus photographs alongside patient data such as age, BMI, smoking habits, and blood pressure to predict conditions like heart disease, in addition to identifying eye diseases.<sup>7</sup> AI's success relies on advancements in computing, algorithmic research, and large data sets, demonstrating immense potential for its application in dentistry and medicine.<sup>8</sup>

### Augmented Reality and Virtual Reality

Dentistry demands the integration of vast data and clinical skills. Augmented reality (AR) overlays computer-generated images on a user's view of the real world, enhancing prosthetic design and patient experiences.<sup>9</sup> AI algorithms in AR allow patients to "try

on" prosthetics virtually, which can be adjusted before final production to meet precise specifications.<sup>10</sup> In contrast, virtual reality (VR) is a 3D computer-generated simulation that interacts with the physical world. In combination with AI, VR has been employed as a tool to alleviate patient anxiety and manage pain that may not respond to medication.<sup>11</sup>

### Artificial Intelligence in Dentistry

**Operative Dentistry:** AI has been used to detect dental caries, vertical root fractures, apical lesions, and assess pulp space volumetrically.<sup>12</sup> Studies show that AI is effective and cost-efficient for diagnosing proximal caries in comparison to dentists' evaluations.<sup>8</sup>

**Periodontics:** Despite treatment advances, diagnosing and predicting the prognosis of periodontally compromised teeth (PCT) remains a challenge. AI offers promising accuracy in diagnosing and forecasting the need for tooth extraction in PCT.<sup>13</sup>

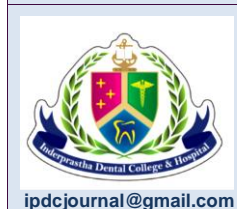
**Dental Public Health:** AI can assist in diagnosing, preventing, and controlling dental diseases through research, education, and public dental care programs.<sup>14</sup>

**Oral and Maxillofacial Radiology:** AI is applied in radiology to reduce image distortion caused by radio-opaque objects, enhance radiographic images, and reduce radiation dosage while improving diagnostic accuracy.<sup>15</sup>

**Pediatric Dentistry:** AI is applied similarly in pediatric dentistry as in adults, offering preventative and therapeutic oral health diagnosis. AR is also used to educate families about disorders and treatment.<sup>16</sup>

**Prosthodontics:** AI aids in tooth shade selection, automated restoration design, and optimizing the all of

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manufacturing processes. It also assists in predicting facial changes in patients with removable prostheses and designing removable partial dentures.<sup>17</sup>

**3D Digital Dentistry:** AI and 3D imaging technologies allow dental professionals to digitize procedures, enhancing accuracy, quality, and efficiency while reducing costs and time.<sup>18</sup>

## CONCLUSION

Despite AI's potential in dentistry, it is not yet capable of replacing human dental professionals. AI should be considered a supplementary tool that enhances dental care and decision-making. Safe and controlled integration of AI into dentistry is crucial to ensuring humans remain in control of treatment. Institutions need to prioritize education and training for effective AI implementation. Augmented reality (AR), virtual reality (VR), and mixed reality—integrating AI, VR, and AR—offer significant advantages in learning and surgical planning. While early AI applications in dentistry are promising, the technology is still evolving. AI-based tools hold great promise as valuable resources for dental professionals, particularly in improving clinical solutions and enhancing treatment accuracy, efficiency, and affordability.

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# Graphene: An Advanced Nano Material in Dentistry

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## ABSTRACT

Graphene is a material that defies expectations with its remarkable qualities. Graphene, a single-layer carbon material, exhibits exceptional properties such as high strength, electrical conductivity, and thermal conductivity. Its unique electronic structure and versatility make it a promising candidate for a wide range of applications. This paper explores the potential of graphene that can be used in the field of dental sciences. Despite challenges such as mass production and cost, graphene's promising outlook suggests its significant role in shaping future technologies.

**Key-Words:** Dentistry, Graphene, Nanomaterials

## INTRODUCTION

Nanotechnology is a multidisciplinary field of research spanning several diverse disciplines, such as biology, chemistry, engineering, materials, medical science, and physics. In particular, nanotechnology involves the creation and development of novel materials and devices through the manipulation of properties and functions of matter at the nanometer scale<sup>1</sup>. Nanomaterials have showed wonderful performances in improving the strength and resist wear of tooth fillers and sealants. Moreover, nanomaterials also performed excellent antimicrobial properties in the application of restorative materials (Sharan et al., 2017). Among various nanomaterials, graphene, as a promising two dimensional (2D) carbon-based nanomaterial, is the thinnest and strongest material. In 2004, it was first isolated by Novoselov and Geim using mechanical exfoliation with a sticky tape and they won the Nobel Prize in 2010 (Novoselov et al., 2004). Graphene based materials could be divided into four categories: single-layer graphene, few-layered graphene, graphene oxide (GO) and reduced graphene oxide (rGO) (Bei et al., 2019). Owing to perfect physical properties, well electrical conductivity, and excellent biocompatibility, graphene and its derivative have attracted much attention in the field of medicine and biomedical fields. Moreover, the graphene and its derivatives have also

aroused great attentions in the field of dentistry and tissue engineering, dental implant coatings, bone cements, resin additives, and tooth whitening.<sup>2</sup>

## Chemistry About Graphene

Graphene is an ultimate incarnation of the surface: It has two faces with no bulk in between. Although this surface's physics is currently at the centre of attention, its chemistry has remained largely unexplored. What we have so far learned about graphene chemistry is that, similar to the surface of graphite, graphene can adsorb and desorb various atoms and molecules (for example, NO<sub>2</sub>, NH<sub>3</sub>, K, and OH).<sup>3,4</sup> An alternative to the surface chemistry perspective is to consider graphene as a giant flat molecule (as first suggested by Linus Pauling). Like any other molecule, graphene can partake in chemical reactions. The important difference between the two viewpoints is that in the latter case, adsorbates are implicitly assumed to attach to the carbon scaffold in a stoichiometric manner—that is, periodically rather than randomly.<sup>5</sup>

## Synthesis of Graphene-Based Nanomaterials

Graphene generally can be synthesized from both top-down and bottom-up routes. The top-down route includes micromechanical cleavage of graphite, liquid-phase exfoliation, and chemical exfoliation of graphite to produce GO, followed by chemical or thermal treatments to obtain rGO or TRG, Graphene generally can be synthesized from both top-down and bottom-up routes.<sup>6</sup> The top down route includes micromechanical cleavage of graphite, liquid-phase exfoliation, and chemical exfoliation of graphite to produce GO, and

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followed by either chemical or thermal treatments to obtain rGO or respectively. The bottom-up fabrication route includes chemical vapor deposition and epitaxial growth on the SiC substrate.<sup>7</sup>

## Dentistry-Related Property of Graphene and Its Derivatives

### 1. Biocompatibility and Cytotoxicity

To develop the application of graphene-based materials in dentistry, it is necessary to evaluate the biocompatibility and cytotoxicity of graphene-based materials (Olteanu et al., 2015). Many researchers have been discussed the cytotoxicity of graphene and its derivatives. Up to date, the affected factors involved concentrations, surface functionalization, and so on.<sup>8</sup>

### 2. Antibacterial Property

As an excellent biomaterial in dentistry, low cytotoxicity and multi-differentiation ability are necessary. Except for these, antibacterial property cannot be ignored. The antibacterial effect of graphene-based materials was firstly discovered by Hu et al. (Hu et al., 2010). Then, more and more researchers had confirmed the antibacterial effect.<sup>9</sup>

### 3. Stimulation of Cell Differentiation

Ideal biomaterials in the tissue engineering show the ability to induce the adherence, proliferation, and differentiation of cells.<sup>10</sup> Many in vitro studies have shown that graphene and its derivatives showed the multi-differentiation ability such as osteogenic differentiation and regeneration of dental pulp. Similarly, periodontal tissue engineering also required scaffolds to achieve an ideal therapy for periodontitis.<sup>11</sup>

## DENTAL APPLICATIONS OF GRAPHENE-BASED MATERIALS

With the improved synthesis methods, expanded types of graphene-based materials, and engineered properties, various applications have been collected and discussed as follows. In addition, a main summary of graphene-based materials used in the dental field:

### 1. Tissue Engineering

Tissue engineering is widely used in the repair and regeneration of various defects caused by tumour, traumas, infections, and so on.<sup>12</sup> It is well known that the scaffolds provide a platform for the attachment, proliferation, and differentiation of different stem cells in the tissue engineering. Many researchers proved that graphene-based materials were suitable for fabricating or coating for scaffolds in the tissue engineering.

### 2. Dental Pulp Regeneration

The neural and odontogenic differentiation induced by graphene-based materials were also observed. Graphene dispersion can be applied.<sup>13</sup>

### 3. Periodontal Tissue Regeneration

As we know, periodontitis is an inflammatory disease with dramatic destruction in periodontal tissue such as periodontal ligament, alveolar bone, and cementum. With the deterioration of periodontitis, the tooth faced the fate of losing, which led to many functional disorders.<sup>14</sup> Therefore, it is quite urgent to regenerate and appealed many researchers. Compared with graphene and rGO, GO showed the hydrophilic surface and good dispersibility, which facilitated the absorption of some related proteins.<sup>15</sup>

### 4. Adhesives, Cements and Silane Primer

Adhesives and cements are two kinds of common materials in the dental restorations. Although they showed the advantages of aesthetic effect and high hardness, the problems of high polymerization shrinkage and bad antibacterial property limited their development.<sup>16</sup> Silane primer played an important role in the bonding of zirconia. Owing to various advantages of graphene-based materials, it has been applied to reinforce the properties of adhesive materials (Farooq et al., 2021). Graphene nanoplatelets (GNPs) are usually prepared as fillers of polymer dental adhesives because of the anti-microbial and antibiofilm activity. The nano composites filled with GNPs have been shown to effectively inhibit the active of S.<sup>17</sup> Mutans cells without compromising the bonding properties. When graphene nanosheets were added to two kinds of calcium silicate cements in powder form of different proportions, GNP–cement composites do well in shortening the bonding time and increasing the hardness of both cements.<sup>18</sup> However, the bonding properties of one cement named Endocem Zr (ECZ) were impaired significantly, indicating that the addition of GNPs may improve the physio-mechanical properties of materials but not ideal for all materials in terms of bonding properties (Nileshkumar et al., 2017). Unlike gray GNPs, bright white fluorinated graphene (FG) may be better filler in dentistry. FG has been used to the modification of GICs, presenting great advantages on the mechanical, tribological, and antibacterial properties. Compared with traditional GICs, the composites not only increase the Vickers micro hardness and compression strength but also decrease the friction coefficient. In the antibacterial properties, the GIC/FG composites achieve good antibacterial properties against *Staphylococci aureus* and *Streptococcus mutans*.

## 5. Coatings for Dental Implants and Abutments

Titanium and its alloys have been widely used in dental implants, owing to their various advantages such as good biocompatibility, high mechanical property, and corrosion resistance (FeRidoun et al., 2017; Jeong et al., 2017; Xie et al., 2014). However, implant failure still occurs. Because of the poor osseointegration and peri implantitis of titanium and its alloys (Berglundh et al., 2019; Smeets et al., 2014; Kordbacheh et al., 2019).<sup>19</sup>

## 6. Teeth Whitening

As we know, hydrogen peroxide ( $H_2O_2$ ) has been widely utilized for in-office whitening for a long time. The  $H_2O_2$  molecules can penetrate deep the teeth and carry out the bleaching process. However, the relative high concentrations of  $H_2O_2$  caused some side effects such as tooth sensitivity and gingival irritation (Carey and Clifton, 2014; Kwon and Wertz, 2015). Therefore, many improved strategies have been made to accelerate the tooth whitening and decrease the side effects. Su et al. reported a cobalt (Co)/tetraphenylporphyrin (TPP)/rGO nanocomposite, which showed better tooth-whitening efficacy stained with dyes, tea, and betel nuts compared with the  $H_2O_2$  only (I Hsuan et al., 2016). In addition,  $H_2O_2$  produces an extremely short lifetime of the active free radical. Therefore, to achieve a good bleaching effect,  $H_2O_2$  must first penetrate into the teeth and quickly produce active free radicals. However, the Co/TPP/ rGO nanocomposite can be used as a catalyst to produce more reactions between the staining molecules and  $H_2O_2$ , which accelerate the bleaching process. In summary, graphene-based materials are a promising catalyst for tooth whitening application with proper types and concentrations.<sup>20</sup>

## 7. Inhibition of the Growth of Fungal

Peri-implantitis is a common reason for the failure of dental implant. In addition, *Candida albicans* was found in the 31% peri implantitis sites, which quickly attracted much attention (Schwarz et al., 2015). The species of *Candida albicans* in peri implantitis patients were five times more than the health individuals (Alrabiah et al., 2019; Alsahhaf et al., 2019). Moreover, owing to the high resistant property of *Candida albicans*, the antifungal treatments are usually failure. The modification of dental implant coatings is a good method to prevent the formation of biofilms. Agarwalla et al. constructed a graphene nanocoating for twice (TiGD) and five times (TiGV) to evaluate the inhibition properties of *Candida albicans* biofilms

(Agarwalla et al., 2020). According to XTT reduction assay, TiGD and TiGV group showed a lower absorbance compared with the control. Then, the colony-forming unit assay that displayed less viable yeast units on the TiGD and TiGV groups at all time points, indicating the inhibition effect of graphene on the fungal biofilm formations<sup>21</sup>. Biosensor for Biomarker Detection From Saliva Dental disease diagnosis can reduce the mortality rates of some serious diseases and improve the quality of life of patients. Owing to its superior electrical and mechanical ability, graphene-based materials are widely used on dental disease diagnosis (Goldoni et al., 2021). Detection of Bacterial and Viral Markers In 2012, Mannoor et al. made the first graphene nanosensors on tooth enamel (Mannoor et al., 2012). They fabricated a graphene sensing element with wireless readout coil attached to the silk fibroin and then transferred onto tooth enamel. The specific biological recognition was acquired by self-assembling AMP graphene peptides onto the graphene.<sup>22</sup>

## 8. Prevention of Enamel and Dentin From Demineralization

White spot lesion (WSL) is one of the most common side effects of orthodontic treatment, which is caused by enamel surface demineralization (Bishara and Ostby, 2008; Nam et al., 2019). Therefore, it is of great significance to overcome WSL in the process of orthodontic treatment. Nowadays, many researchers are focusing on the studying of new bonding agent composites to prevent enamel demineralization caused by bacteria. Owing to the prominent antibacterial activity of GO, Lee and his colleges added GO to a bioactive glass (BAG) (Lee J.-H. et al., 2018). With the increase of GO concentrations, the length of anti demineralization of the GO group increased. Besides, GO containing groups also showed superior antibacterial effect after 24 and 48 h. The anti-demineralization mechanism of the composites may be attributed to the synergic effect of antibacterial effect of GO and the ion-releasing effect of BAG. In conclusion, GO is a promising addition in the anti demineralization of enamel in proper style.<sup>23</sup>

## 9. Drug Delivery

There is close interaction between bacteria and dental caries, and endodontic and periodontal diseases. Several groups of bacteria that require a common antibacterial strategy are usually involved. Amoxicillin (AMOX) is a kind of broad-spectrum antibiotic that is the first-choice antibiotic in the treatment of endodontic infection in Asian and European countries. In the conditional paste, the dose

is not accurately controlled (Nan, 2016). Drug carrier can realize the gradual releasing of antibiotic drugs to easily achieve effective drug concentrations in the infected site. Trusek et al. found that GO had the potential in acting as a drug carrier especially in the therapy of dental inflammation (Trusek and Kijak, 2021). They linked the AMOX to GO using a peptide linker, which is Leu-Leu-Gly and then dispersed in the hydrogel. AMOX was released by enzymatic hydrolysis, showing the effective release of AMOX and the inhibition of bacteria strain growth.<sup>24</sup>

## CONCLUSION

Graphene-based nanomaterials offer promising potential for revolutionizing dentistry. While their unique properties, such as exceptional strength, conductivity, and biocompatibility, make them ideal candidates for various dental applications, several challenges must be addressed before widespread adoption. Despite these hurdles, the potential benefits of graphene-based materials in dentistry are significant. They could lead to the development of more durable dental restorations, improved diagnostic tools, and innovative therapies. Further research and development are essential to fully realize the potential of graphene in this field and to establish its safety and efficacy for clinical use.

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# Nicotine Replacement Therapy (NRT): Safe Usage, Prescription Necessity, and the Role of Comprehensive Tobacco Cessation Programs

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## ABSTRACT

Today tobacco use is the single utmost avertable cause of death in the world. Tobacco use is regularly mistakenly perceived to be exclusively a personal choice. Nicotine is the main active constituent in tobacco products that reinforces individual to tobacco dependence behavior. It is tobacco's other components which cause widespread mortality and morbidity. Though almost all of the toxicity of smoking is attributed to other components in cigarettes, it is the pharmacological effects of nicotine that lead to tobacco addiction. Therefore, pharmacological interventions for tobacco cessation continue to evolve with our growing knowledge of the neurochemical basis of nicotine addiction. Nicotine is the main alkaloid of tobacco smoke and the principal modulator of the psychopharmacological effects associated with addiction. Nicotine replacement therapy (NRT) aims to reduce motivation to consume tobacco and the physiological and psychomotor withdrawal symptoms through delivery of nicotine.

**Key-Words:** Tobacco, Nicotine, Nicotine Replacement Therapy, Addiction, Cigarettes

## INTRODUCTION

Tobacco addiction is a global public health issue, responsible for millions of preventable deaths every year. While most smokers are aware of the health risks, quitting smoking remains an incredibly difficult task due to nicotine dependence and the psychological aspects of addiction. Nicotine Replacement Therapy (NRT), available in various over-the-counter (OTC) forms such as patches, gums, lozenges, inhalers, and sprays, offers a scientifically-backed method to assist smokers in quitting. NRT reduces withdrawal symptoms and cravings by delivering nicotine without the harmful chemicals found in tobacco smoke, significantly increasing the chances of quitting successfully.<sup>1</sup> However, NRT is not without risks. Nicotine is still an addictive substance with potential side effects, and the improper use of NRT can lead to complications. This raises the question: Should NRT be prescription-based to ensure its safe and effective use? In this article, we will explore the safe usage of NRT, its benefits and risks, and the need for prescription oversight. We will also discuss how comprehensive tobacco cessation programs, such as the ICanCaRe

Tobacco Wellness Program, integrate NRT with behavioral support to maximize quitting success.

### Benefits of NRT Products

NRT has been proven effective in helping individuals quit smoking. By delivering nicotine in controlled doses, it helps reduce the severity of withdrawal symptoms such as irritability, anxiety, depression, insomnia, and cravings, making it easier for smokers to stop.<sup>2</sup> A systematic review by the Cochrane Collaboration found that NRT can double or triple the likelihood of quitting compared to using no aids.<sup>1</sup> Importantly, NRT is safer than smoking. While it provides nicotine, which is the addictive substance in tobacco, it does not contain the thousands of harmful chemicals like tar and carbon monoxide that contribute to the health risks associated with smoking, such as lung cancer, heart disease, and respiratory issues.<sup>3</sup> By switching to NRT, smokers are exposed to significantly fewer toxins, making it a safer option for those trying to quit.

### Types of NRT Products

NRT is available in several forms, each with different modes of delivery, durations of action, and user preferences:

*Nicotine Patches:* Provide a steady dose of nicotine throughout the day, Easy to use, making them ideal for regular smokers with consistent cravings.

*Nicotine Gum:* Delivers nicotine when chewed, and so

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allowing users to manage cravings as they occur. Ideal for smokers who need more flexibility in nicotine dosing.

*Nicotine Lozenges:* Dissolve slowly in the mouth, providing gradual nicotine delivery. Preferred by users who dislike chewing gum.

*Nicotine Inhalers:* Mimic the hand-to-mouth action of smoking, providing psychological comfort. Deliver rapid nicotine relief for smokers who miss the habitual actions of smoking.

*Nicotine Nasal or Oral Sprays:* Offer the quickest relief by delivering nicotine directly through the nasal or oral membranes. Suitable for users who experience sudden, intense cravings.

## Safe Use of NRT

While NRT products are effective, they must be used correctly to ensure safety and success. Many smokers may be unaware of the proper way to use NRT, leading to potential misuse, side effects, and even nicotine overdose. Common side effects include skin irritation from patches, mouth ulcers from gums, throat irritation from inhalers, and nausea from lozenges. More severe reactions like irregular heartbeat or allergic responses are rare but can occur, particularly if the dosage is too high.<sup>3</sup> To use NRT safely and effectively, it is crucial to:

### 1. Set a Quit Date

Choose a date to quit smoking and begin using NRT. Having a plan in place, along with support from family, friends, or a professional, increases the chances of success.

### 2. Choose the Right Product

The choice of NRT product depends on smoking habits. Patches work well for steady, consistent smokers, while lozenges or gum may be better suited for those who experience occasional cravings.

### 3. Follow Instructions

Carefully follow dosage instructions and guidelines. Avoid using multiple NRT products simultaneously unless advised by a healthcare provider. Misusing products by applying too many patches, chewing excessive gum, or overusing sprays or inhalers can lead to nicotine overdose, which may result in symptoms such as nausea, dizziness, and even seizures in extreme cases.

### 4. Combine NRT with Behavioral Support

NRT is most effective when combined with counseling or behavioral interventions. Smoking is both a physical and psychological addiction, and addressing both aspects is essential for long-term success.

### 5. Taper Off Gradually

NRT should be used as the temporary aid to quit this

not as a long-term replacement. Over time, users should reduce the dosage and frequency of NRT, eventually stopping completely after 8-12 weeks.

## Why NRT Should Be Prescription-Based

Currently, NRT products are available OTC in many countries, meaning anyone can purchase them without consulting a doctor or pharmacist. While OTC availability increases access to NRT, it also presents risks that could be mitigated by requiring NRT to be prescription-based.

### 1. Nicotine's Health Risks

Nicotine is not a harmless substance. Although it is less harmful than smoking, nicotine can still negatively impact the cardiovascular, nervous, and reproductive systems. In some cases, it may also interact with medications, leading to adverse effects. Without medical supervision, users may not be aware of these risks, increasing the likelihood of complications.

### 2. Improper Usage

Many users may not understand how to use NRT correctly. Choosing the right dosage, duration, and product type is critical to quitting success. Users may also fail to recognize the signs of overdose or other side effects. Under medical supervision, individuals can receive personalized advice to ensure the safe and effective use of NRT.

### 3. Lack of Behavioral Support

NRT is most effective when combined with behavioral counseling that addresses the psychological aspects of addiction. However, many smokers using OTC NRT products may not have access to this critical support. Prescription-based NRT would allow healthcare professionals to offer guidance on behavioral interventions and ensure that users receive comprehensive quit plans.

### 4. Risk of Nicotine Dependence

Although NRT is designed as a short-term aid, some users may become dependent on the products, using them for longer than recommended or in combination with other nicotine sources, such as cigarettes or e-cigarettes. Medical oversight could prevent prolonged nicotine use by encouraging users to gradually taper off NRT products.

### 5. Misuse and Abuse

OTC availability increases the risk of misuse. For example, individuals may use more than the recommended dosage, leading to nicotine toxicity.

Prescription requirements would ensure that users are educated on proper use, reducing the likelihood of abuse. By making NRT prescription-based, healthcare providers can assess each individual's needs, recommend the appropriate product and dosage, and offer ongoing support to ensure successful cessation. This medical oversight would not only improve the safety and effectiveness of NRT but also reduce the risk of misuse, complications, and prolonged nicotine dependence.

### The ICanCaRe Tobacco Wellness Program: A Comprehensive Approach

The ICanCaRe Tobacco Wellness Program offers a holistic, evidence-based approach to quitting smoking, integrating NRT with behavioral support, counseling, and personalized care. Our program starts with an in-depth assessment of each participant's tobacco use, medical history, and psychological needs. Based on this evaluation, we create a customized quit plan that includes:

- **NRT Selection and Guidance:** We help users choose the right NRT product and dosage while providing continuous monitoring to ensure safe usage.
- **Behavioral Counseling:** Through individual and group counseling sessions, we address the psychological and emotional aspects of quitting smoking, helping users build coping mechanisms and strategies for long-term success.
- **Ongoing Support:** The ICanCaRe mobile app provides users with motivational content, progress tracking tools, and direct access to trained counselors for real-time support.

By combining NRT with counseling and continuous support, the ICanCaRe program significantly improves the chances of successfully quitting smoking and maintaining a tobacco-free lifestyle.

### CONCLUSION

Nicotine Replacement Therapy (NRT) is a valuable tool in the fight against tobacco addiction, offering smokers a safer alternative to cigarettes. However, the improper use of NRT, its associated health risks, and the potential for misuse underscore the need for prescription-based access. By requiring medical supervision, we can ensure that NRT is used safely and effectively, while also providing smokers with the behavioral support they need to quit successfully. The ICanCaRe Tobacco Wellness Program exemplifies the

comprehensive approach to tobacco cessation, combining NRT with personalized care and ongoing support to help individuals quit smoking and stay smoke-free for life.

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