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Awareness, Knowledge and Attitude of Dental Professionals Regarding the Role of CPP-ACP in Caries Prevention – A Questionnaire study

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Abstract:-

- ***Background***

The goal of modern dentistry is to manage non-cavitated caries lesions non-invasively through remineralization in an attempt to prevent disease progression and improve aesthetics, strength, and function. CPP-ACP provides a new direction to preventive dentistry.

- ***Aim***

To assess the knowledge and attitude among the dentists regarding CPP-ACP as a preventive paradigm.

- ***Material and methods***

250 dentists were included in the questionnaire survey. The questionnaire contained 21 close-ended questions. Validated questionnaire on google forms was circulated among the participants via social media. Data from Google forms was entered into excel sheets and SPSS 23 software was used for inferential analysis.

- ***Results***

Among the 250 dentists, 123 were postgraduates, 83 were general practitioners and 44 were interns. The Postgraduate practitioners (49%) had better knowledge about the basics of CPP-ACP followed by general practitioners (33%) and interns (18%).

- ***Conclusion***

Most of the dentists are aware about CPP-ACP as a remineralizing agent, but its use is limited in their practice.CPP-ACP should be integrated in the dental practice and newer protocols should be formulated to include CPP-ACP as a preventive strategy in caries prevention.

Keywords:- *CPP-ACP, Remineralization, Pediatric Dentistry.*

I. INTRODUCTION

White spot lesions are manifestations of the earliest stage of caries progression and can be reversed, but if the stage of demineralization persists, it ultimately leads to cavitation. (1)

Modern day dentistry has shifted the focus from G.V Black's "extension for prevention" to "prevention of extension". Non-invasive management of non-cavitated carious lesions through remineralization is being now emphasized in order to prevent disease progression, and to improve aesthetics, strength and function of teeth.

Fluorides are agents that inhibit demineralization and promote remineralization. The ability of fluoride to promote remineralization is limited by the availability of phosphate and calcium ions. (2) Moreover, fluoride might be efficient on smooth surface caries but its effect is limited on pit and fissure caries. These limitations have prompted researchers to search for non-fluoridated alternatives for remineralization.

Non-fluoridated agents like Casein Phosphopeptide Amorphous Calcium Phosphate (CPP-ACP), Tricalcium Phosphate, Bioactive Glass, Xylitol, Unstabilised Calcium Phosphate with Sodium Fluoride, Arginine Bicarbonate calcium carbonate complex, Calcium carbonate carrier, Grape Seed Extract, Ozone helps in preventing demineralization of Carious Lesion.

This quest of mankind for novel materials to overcome the carious challenge has led to the introduction of CPP–ACP.

CPPs are known for their ability to stabilize calcium and phosphate ions, preventing them from precipitating out of solution. This property helps in maintaining a reservoir of calcium and phosphate in the mouth.

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Amorphous Calcium Phosphate (ACP**)** is a form of calcium phosphate that lacks a crystalline structure, making it highly soluble and bioavailable. It can be incorporated into dental care products to aid in the remineralization of tooth enamel.

CPP-ACP nano-complex has a synergistic effect on fluorinated compounds. This synergistic effect must be attributed to the formation of nano agglomerates of Ca, F, and P ions (CPP-ACP/F), which leads to an increase in fluoride ions in plaques and an increase in bioavailable Ca and P concentrations ions. [3]

The size and electro neutrality of the CPP nanocomplexes allows them to diffuse down the concentration gradient into the body of the sub-surface lesion. Once present in the enamel sub-surface lesion (white spot lesion), the CPP-ACP releases the weakly bound calcium and phosphate ions, depositing them into crystal voids. The CPPs have a high binding affinity for apatite thus, on entering the lesion, the CPPs binds to the more thermodynamically favored surface of an apatite crystal face. It is pH responsive, i.e. with increasing pH, the level of bound ACP increases, stabilizing free calcium and phosphate and thus provides an anti-caries action. [4]

To the authors' knowledge, there is sparse literature on the attitude of dentists in prescribing CPP-ACP agents as a remineralising agent. Due to lack of knowledge, dentists are unaware about the potential benefits of using CPP-ACP in caries prevention. Therefore, this study was conducted to assess the knowledge and attitude of dentists regarding the role of CPP-ACP in the prevention of dental caries progression.

II. MATERIALS AND METHODS

The study protocol was approved and received ethical approval (SRB/PEDO24/08/V1) from the institutional review board ethical committee.

A questionnaire was prepared based on previous studies. [5] The questionnaire consists of two parts. In the first part, participants were asked to enter basic demographic details. In the second part, questions related to participant's knowledge and attitude on CPP-ACP.

Dentists, with qualification of Master of Dental Surgery (MDS) across various dental specialties except for Paediatric dentists, Interns, and General practitioners were included in this study. 250 dentists who were ready to give their consent to answer the questionnaire were selected as participants. The questionnaire consisted of 23 questions related to the knowledge about CPP-ACP which included the mode of action, synergistic potential for remineralization, effectiveness along with fluoride and reduction in the streptococcus mutans count, different forms in which it is available and mode of delivery.

Data were collected using an electronic questionnaire disseminated through Google Forms. The collected data were entered in an Excel sheet and analysed using Statistical Package for Social Sciences [SPSS] for Windows Version 22.0 Released in 2013. Armonk, NY: IBM Corp., will be used to perform statistical analyses.

Descriptive analysis of all the explanatory and outcome parameters will be done using mean and standard deviation for quantitative variables, and frequency and proportions for categorical variables. Statistical weights of score "1" were assigned for "Correct" responses and score "0" for "Incorrect" responses. Total scores for the responses were derived to facilitate the comparison based on the sociodemographic characteristics of the study Mann-Whitney test was used to compare the mean sum scores for the responses based on the gender of the study participants.

Kruskal Wallis test was used to compare the mean sum scores of responses based on the age group & years of practice of the study participants. The level of significance will be set at $P<0.05$. And any other relevant test, if found appropriate during the time of data analysis will be dealt with accordingly.

III. RESULTS

Taking into consideration the 250 filled questionnaires, the response to the question asked if dentists were familiar with the use of CPP-ACP in dental care products, 221 dentists (89.1%) were familiar whereas 27 dentists (10.9%) were not familiar.

246 dentists (98.4 %) dentists were aware that carious lesions are reversible via remineralization, and only 4 dentists (1.6 %) were unaware of it.

183 dentists (72.9 %) dentists knew that calcium, phosphate, and fluoride are the ideal minerals that help to repair and strengthen tooth structures that have been affected by demineralization.

191 dentists (76.7 %) knew the abbreviation of CPP-ACP was Casein phosphopeptide amorphous calcium phosphate, remaining 59 dentists (23.3 %) gave the wrong answer. 234 dentists (94.7 %) dentists knew that CPP-ACP is the remineralizing agent. 196 dentists (78.7 %) knew that Casein is the predominant phosphoprotein present in bovine milk, while 22(8.8 %) and 31(12.4%) dentists thought yogurt and cheese respectively were the predominant phosphoprotein.

157 dentists (64.3%) were aware that CPP-ACP must not be used in children with lactose intolerance, whereas 87 dentists (35.7 %) were unaware of it.

153 dentists (62.2%) knew that the CPP-ACP mode of action by stabilizing high concentrations of calcium and phosphate ions at the tooth surface and binding to pellicle and plaque. 82 dentists (33.3 %) and 11 dentists (4.5%) thought the mode of action is by stabilizing high concentrations of calcium and phosphate ions at the tooth surface and binding to pellicle and plaque respectively.

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225 dentists (91.5%) knew that CPP-ACP has anti-carcinogenic properties while 21 dentists (8.5%) think it doesn't have. 231 dentists (93.5%) knew that CPP-ACP helps in the reversal of white spot lesions, whereas 16 dentists (6.5%) said that it doesn't help in reversal86 dentists (35.5%) knew that CPP-ACP reduces the level of Streptococcus mutans.14 dentists (5.8%) thought lactobacillus levels are reduced. 142 dentists (58.7%) thought both S.mutans and Lactobacillus levels are reduced by using CPP-ACP.

222 dentists (91%) knew that CPP-ACP can be used in the prevention of orthodontic decalcification. 226 dentists (93.4%) knew that CPP-ACP is effective along with fluoride. 55 dentists (22.4%) knew that CPP-ACP produces synergistic potential for remineralization with fluoride.154 dentists (62.9%) thought that calcium, phosphate, and fluoride all together produce a synergistic effect with CPP-ACP.

48 dentists (19.6%), 10 dentists (4.1%), 10 dentists (4.1%), and 51 dentists (20.8%) thought that mode of delivery of CPP-ACP are chewing gums, mouth rinses, sealants, and toothpaste respectively. 126 dentists (51.4%) knew that all chewing gums, mouth rinses, sealants, and toothpaste are different modes of delivery of CPP-ACP.

226 dentists (93%) knew that CPP-ACP can be added to dental varnish and 219 dentists (90.1%) knew that CPP-ACP can be used in Molar Incisor Hypo-mineralization (MIH) cases.

77 dentists (31.4%) thought that CPP-ACP is more effective for children from 0-6 years. 40 dentists (16.3%), 11 dentists (4.5%), and 2 dentists (0.8%) knew that it is more effective in people under 7-18 years,19-35 years and 35-65 years respectively.115 dentists (46.9%) knew that CPP-ACP is believed to be more effective in all ages.

The knowledge about CPP-ACP among interns, postgraduates, and general practitioners was evaluated. The Postgraduate practitioners had better knowledge about the basics of CPP-ACP followed by general practitioners and interns. There was better knowledge about CPP-ACP among the Endodontists and Orthodontists than any other specialties.

237 dentists (96.7%) preferred to recommend CPP-ACP as a preventive measure for patients with white spot lesions. 241 dentists (97.6%) predict an increasing role for CPP-ACP in future dental practices.180 dentists (74.4%) were interested in additional training or continuing education program (CDE) on CPP-ACP.

IV. DISCUSSION

The current study was done to assess the knowledge and attitude of the dentists about CPP-ACP as a preventive paradigm in dentistry, a closed-ended questionnaire is more effective.

The study revealed that the participant's knowledge regarding the application of CPP-ACP in preventing dental caries was limited. This research revealed that many dentists are not familiar with CPP-ACP as a preventive measure.

CPP–ACP is a milk product that helps in remineralization and prevents dental caries. Casein phosphopeptide can deliver amorphous calcium phosphate (ACP) and can also help the ACP to bind with the dental enamel. Also since CPP–ACP is a milk product, it cannot be given to patients having intolerance to milk. Therefore, a suitable alternative for these patients is required. Demineralization can be prevented by casein, which can buffer plaque acid either directly or through bacterial catabolism. It has the ability to break down amino acids that accept protons and act as buffers.

The most commonly used form of CPP-ACP is sugar-free sorbitol or xylitol-based chewing gum. Other vehicles include milk, mouthwashes, lozenges, topical creams, sprays, and energy drinks. Unlike fluoride, CPP-ACP can be added to sugary foods and therefore has commercial potential as an additive in foods and toothpastes to combat dental caries. [6]

The combination of CPP-ACP and fluoride by Mazzaoui et al in 2003 demonstrated a synergistic remineralization potential, [7] many dentists were unaware of this. Kariya et al's findings indicated that the addition of fluorine to CCP-ACP resulted in an improvement in acid resistance performance, indicating that it is more effective and durable than other acids. [8] Combination of CPP–ACP in fluoride varnish seems to enhance the caries preventive potential of fluoride varnish by inhibition of demineralization and antibacterial activity against S.mutans. [9]

Reynolds EC et al. did a study in 2003 and showed that when CPP-ACP was in mouthwash, it caused an increase in calcium and phosphate in supragingival plaque. [10] CPP-ACP has been shown to act as a calcium phosphate reservoir by increasing plaque calcium and phosphorus levels up to five times in human in situ models of dental caries. This ensures that the super saturation of enamel minerals is maintained, thereby decreasing the process of demineralization and increasing the rate of remineralization. Thus, CPP is an excellent vehicle to localize bioavailable calcium, fluoride, and phosphate ions to the tooth surface to remineralize subsurface enamel lesions with fluorapatite.

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Cardoso-Martins et al in 2022 conducted an in vitro study that found a significant increase in MIH-induced enamel physical strength after topical application of CPP-ACP, possibly due to increased mineral content. The mineral density of hypo-mineralized and transitional areas of enamel increased significantly after treatment with CPP-ACP tooth mousse in both white and yellow opacities. [11]

Casein phosphopeptide can also reduce the number of Streptococcus Mutans due to its ability to incorporate into the membrane. [6]

Chewing CPP-ACP gum three times a day resulted in a significant reduction in S. mutans saliva after three weeks. This concluded that CPP-ACP has an inhibitory effect on S. mutans and possibly other oral bacteria, which may contribute to its anticariogenicity in vivo. [13]

A xylitol-containing gum with CPP-ACP is proven to produce a dose-related increase in enamel remineralization. [14]

In a clinical study by Simon LS et al., it was observed that CPP-ACP had desired and durable aesthetic improvement in terms of reduction in the area as well as colour of post orthodontic white spot lesions. In an in-vitro study, Alagha E et al concluded that CPP-ACP containing varnish had a higher remineralizing effect when compared to TCP (tricalcium phosphate) containing varnish. [15]

When a combination of CPP and amorphous calcium fluoride phosphate (ACFP) is used, in addition to the combination of CPP and ACP, CPP stabilizes ACFP in the same way as ACP. In this scenario, the degree of saturation would increase because phosphate, calcium, and fluoride ions are located on the tooth surface and this would increase remineralization, which was also reported in an in vitro study. [16]

The addition of the CPP-ACP complex to restorative dental materials is also a potential area for further research. Some researchers have already added CPP-ACP to glass ionomer cement (GIC) and concluded after an in vitro study that GIC containing CPP-ACP increased dentin protection during an acid attack. [7]

The questionnaire-based cross sectional study conducted by Sophiya et al [5], concluded that Most of the dentists were unaware about CPP-ACP in most of the aspects. The postgraduate practitioners (80%) had better knowledge about the basics of CPP-ACP than the undergraduate practitioners (40%).

Another questionnaire-based cross sectional study conducted by Pooja et al [17], explored general dentists' knowledge, attitudes, and practices regarding preventive pedodontics in India. The study identified a range of preventive measures used, including fluoride applications, sealants, and newer technologies like Silver Diamine Fluoride. Familiarity with CPP-ACP agents were noted among 71.83% of respondents, while 9.39% were not familiar with them, and 18.78% were unsure. In terms of usage, 43.19% of respondents use CPP-ACP agents, while 56.81% did not.

The advantages of the present study included the huge sample size that provided responses from a wide range of professionals to ensure better results. However, further research can be encouraged to ensure that the dentists are aware of the role of CPP-ACP.

V. CONCLUSION

The knowledge about CPP-ACP among interns, postgraduates, and general practitioners was evaluated. The Postgraduate practitioners had better knowledge about the basics of CPP-ACP followed by general practitioners and interns.CPP-ACP should be integrated in the dental practice and newer protocols should be formulated to include CPP-ACP as preventive strategy in caries prevention.

Conflict of Interest: Authors declare no conflict of interest

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TABLES

Table 1: Table Enumerating the Results of Knowledge Related Questions among Participants

At the early stage of carious lesion, is the carious lesion reversible via remineralization?	
Yes	98.4%
No	1.6%
Ideal minerals that help to repair and strengthen tooth structures that have been affected by demineralization?	
Calcium	8.7%
Phosphate	0.8%
Fluoride	17.5%
All of the above	73%
Are you familiar with CPP- ACP in dental care products?	
Yes	89.2%
No	10.8%
Do you know the abbreviation of CPP- ACP?	
Casein phosphopeptide amorphous calcium phosphate	76.8%
Casein phosphoprotein amorphous calcium phosphate	23.2%
Casein is a predominant phosphoprotein in	
Bovine milk	78.8%
Yogurt	8.8%
Cheese	12.4%
Can CPP- ACP be used in children with lactose intolerance?	
Yes	64.5%
No	35.5%
CPP- ACP mode of action	
Stabilizing high concentrations of calcium and phosphate ions at the tooth surface	33.2%
Binding to pellicle and plaque	4.5%
Both of the above	62.3%
CPP –ACP is	
Remineralizing agent	94.8%
Revitalizing agent	5.2%
Does CPP –ACP have anti-cariogenic properties?	
Yes	91.5%
No	8.5%
Does CPP- ACP help in reversal of white spot lesions?	
Yes	93.5%

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No	6.5%
Does CPP- ACP reduce the levels of?	
Streptococcus mutans count	35.4%
Lactobacillus count	5.8%
Both of the above	58.8%
CPP –ACP can be used in preventing orthodontic decalcification	
Yes	91%
No	9%
Is CPP- ACP effective along with fluoride?	
Yes	93.4%
No	6.6%
CPP –ACP produces synergistic potential for remineralization with?	
Calcium	14.2%
Phosphate	0.4%
Fluoride	22.4%
All of the above	63%
Preferred mode of delivery of CPP- ACP?	
Chewing gums	19.5%
Mouth rinses	4.1%
Toothpastes	20.7%
Sealants	4.1%
All of the above	51.6%
Can CPP- ACP be added to dental varnish?	
Yes	93%
No	7%
Can CPP- ACP can be used in molar incisor hypo mineralization [MIH] cases?	
Yes	90.2%
No	9.8%
Are there specific patient groups or conditions for which you believe CPP – ACP is more effective?	
0-6 years	31.3%
7-18 years	16.3%
19- 35 years	4.5%
35- 65 years	0.8%
All the above	47.2%

Table 2: Table Enumerating the Results of Attitude Related Questions among Participants

Would you recommend CPP – ACP as preventive measure for patients for white spot lesions?	
Yes	96.7%
No	3.3%
In your opinion, do you foresee an increasing role of CPP – ACP in future dental care practices?	
Yes	97.6%
No	2.4%
Would you be interested in additional training or continued dental education on CPP- ACP?	
Yes	74.5%
No	1.2%
May be	24.3%

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FIGURES

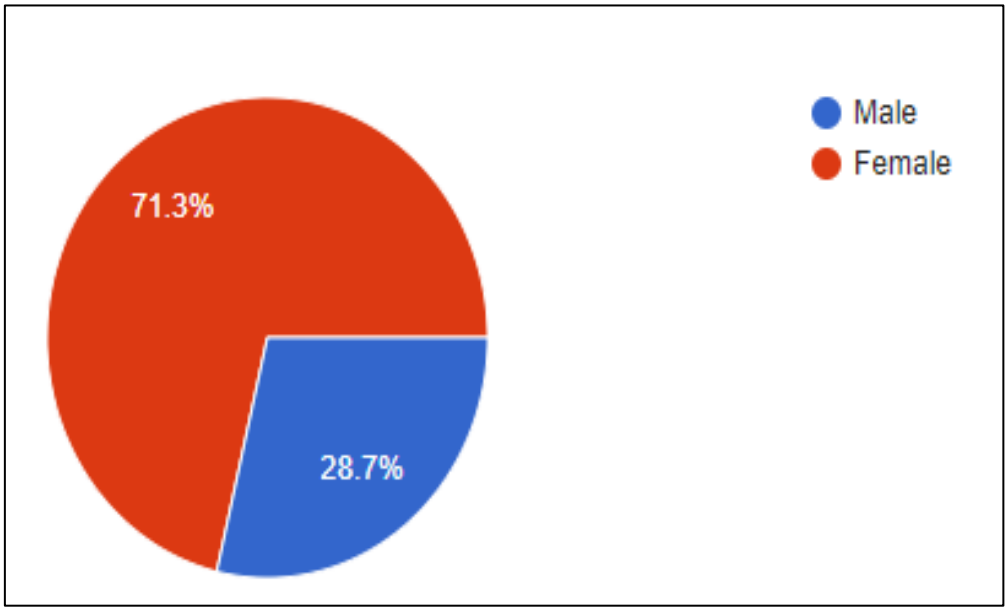

Fig 1: Pie Chart Depicting the Gender Distribution

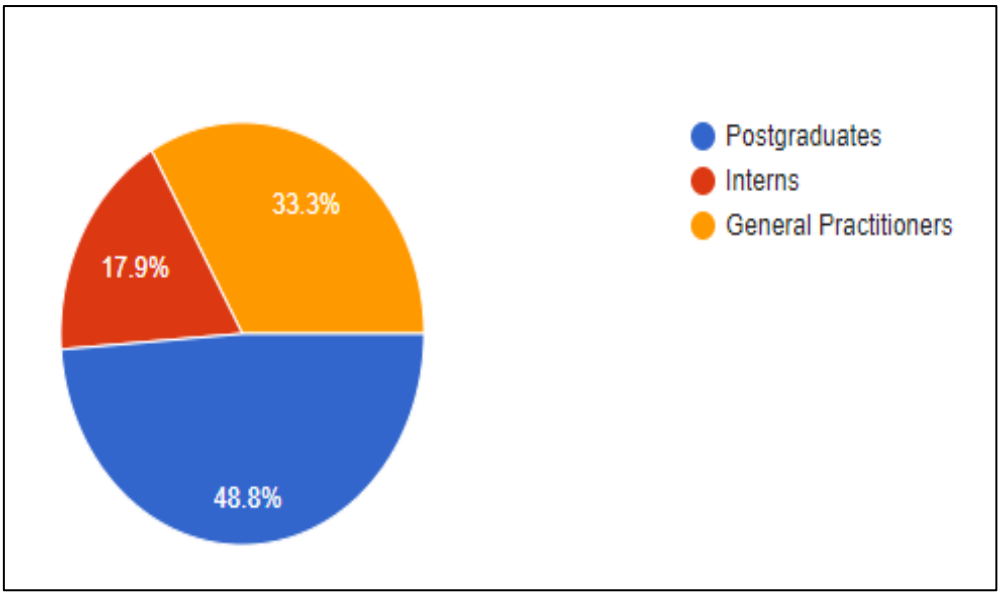

Fig 2: Distribution of Different Education Levels of Dentists in the Study

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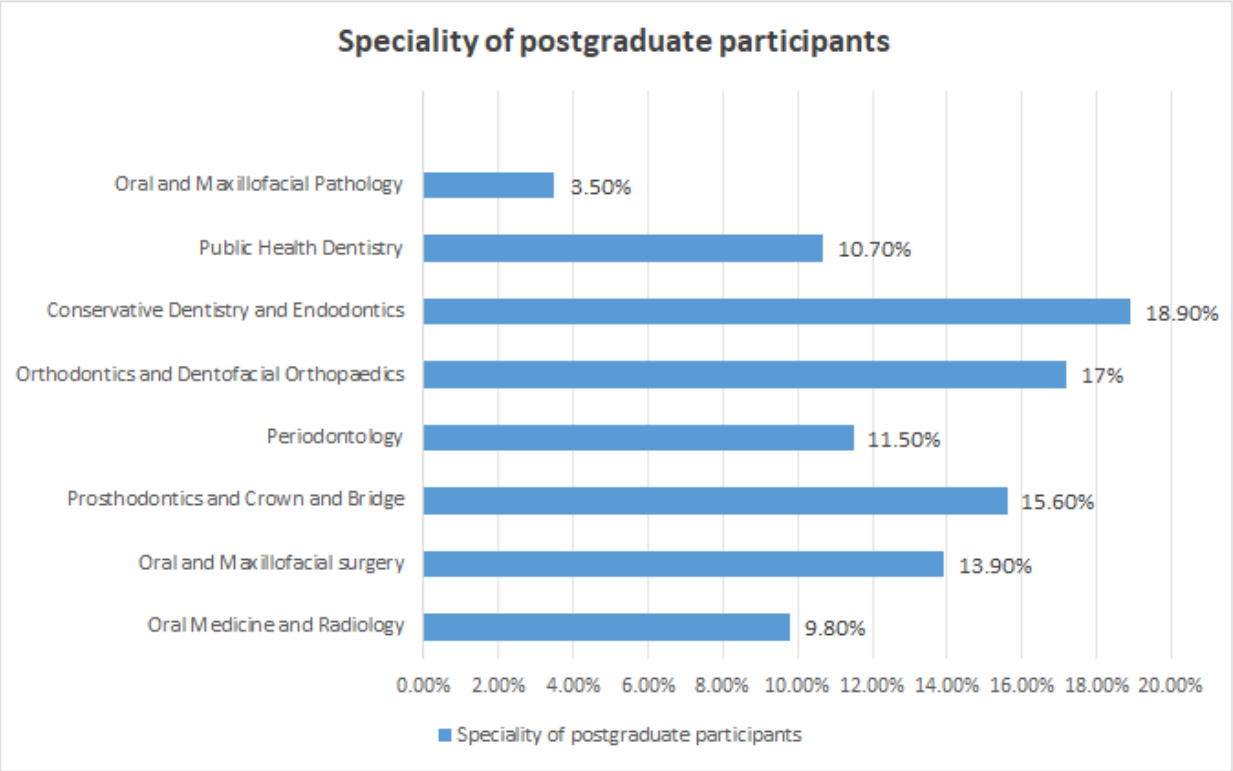

Fig 3: Distribution of Different Speciality of Postgraduate Participants