

## Use of CVDentUS Diamond Tips for Ultrasound in Cavity Preparation

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### Abstract

**Aim:** The aim of this study was to evaluate the use of CVDentUS tips for preparing cavities with ultrasound by dentists certified to use the Chemical Vapor Deposition (CVD) system.

**Methods and Materials:** One thousand sixty (1060) questionnaires were sent via e-mail inquiring about the use of the system with regard to the indication for use, need for anesthesia, final form of cavity preparation, and tip wear.

**Results:** Of the valid answers, 81.4% of the dentists used this system for tooth preparation in up to 60% of cases treated. For these procedures, 17.8% did not require use of local anesthesia while using the system. The final form of preparation compared to high speed diamond tips was considered to be more conservative by 48.3% of the certified professionals. With regard to wear, tip and/or adapter fractures, and low cutting speed, 44.4% of users reported problems.

**Discussion:** The CVD system seems to be used for tooth cavity preparation by the majority of the certified dentists. This is due to the resultant conservation of tooth structure despite the necessity of anesthesia and the limitations with regard to the lack of cutting efficiency of CVDentUS and tip wear.

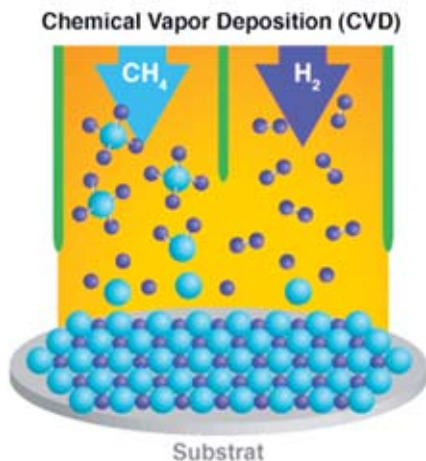
**Clinical Significance:** The CVD system seems to present limitations with regard to cutting efficiency, wear, and the use of anesthesia in a majority of restorative procedures.

**Keywords:** CVDentUS diamond tips, ultrasound, cavity preparation, tip wear

**Citation:** Predebon JC, Flório FM, Basting RT. Use of CVDentUS Diamond Tips for Ultrasound in Cavity Preparation. J Contemp Dent Pract 2006 July;(7)3:050-058.

## Introduction

Developed in São Jose dos Campos, SP/ Brazil by researchers at the National Institute of Space Research - INPE ("Instituto Nacional de Pesquisas Espaciais"), the technological innovation CVD (Chemical Vapor Deposition) allowed the creation of dental diamond tips capable of being coupled with an ultrasound appliance.<sup>1,2</sup> These tips, called CVDentUS, are produced in a reactor in which a mixture of methane and hydrogen gases results in the formation of a single artificial diamond layer without space between the grains on the substrate (a molybdenum rod). Conventional manufacturing methods weld the diamond layer using a galvanic process to the substrate which results in a relatively large area between the diamond grains. This new technique allows the diamond to have sufficient adherence to the metal rod to bear the vibration effect of ultrasound.<sup>2</sup> These tips deliver a cutting power on dental structures, amalgam restorations, and compound resins with morphological differences compared to conventional diamond tips. They may also be used for performing gingival peeling and for unobstructing root canals.



Ultrasound has been in existence for over 50 years.<sup>3</sup> However, when it is used for cavity preparation, deficiencies such as the inefficient removal of carious tissue and slow cutting became apparent.<sup>4</sup> The cost and size of the appliance were additional factors influencing their non-acceptance by dentists.<sup>4,5</sup> Now some limitations of ultrasound have been overcome due to the advent of the CVDentUS diamond tip. These tips are available in several shapes

(cylindrical, tapered-trunk, spherical, and inverted tapered-trunk) and can be used with various brands of ultrasound machines by using specific adaptors. Each type of tip requires the user to set the appliance power to provide sufficient cutting power without fracturing the cutting tip.

The CVDentUS tips present the possibility of offering advantages with regard to the conventional diamond ones used at high speed because they have:

- **Better Cooling:** Cooling water flows over the entire CVDentUS tip rod and reaches the extremity without interference with its trajectory.
- **Less Noise:** Noise occurs only when the point comes into contact with tooth structure.
- **Greater Durability:** As a result of the new manufacturing technology, the resistance of the CVD diamond to displacement is greater than traditional diamond tips.
- **Better Access and Visibility:** CVDentUS tip rods are long which allows the complete working area to be seen. They are also angled to provide better access to inaccessible areas.
- **Effective Cavity Cleaning:** Ultrasound produces a phenomenon called ultrasonic cavitation. Ultrasonic action forms air bubbles in a liquid medium. Many of these bubbles rise to the surface while others grow and implode, releasing a large amount of energy. This energy liberated on implosion causes intense movement of particles and cleaning of surfaces. This is the phenomenon which facilitates the cleaning of the surface of diamond instruments within the ultrasonic environment. It might also serve to clean cavities, but there is still no evidence to support this theory.

Although it is a new technology developed at the end of the decade of the 1990's, its use is just now spreading among dental professionals. Thus, this study aimed to assess the use of CVDentUS tips for preparing cavities using ultrasound by dentists certified in the use of the CVD system.

## Method and Materials

An open questionnaire with multiple alternatives (Figure 1) concerning the use of CVDentUS tips in the consulting room was sent by e-mail to 1060 professionals certified in the use of the CVD system.

The submission of the questionnaire to users was carried out after the project had been approved by the local ethics committee. Only dentists certified in the use of the CVD system took part in the research. Participants were assured of anonymity and guarantee of absence of onus when there was absence of response. In the case of the professional who had not acquired any of the tips, he/she should only inform and respond to question number one. The dentist would have full freedom to reply to the questions and could omit any response if he/she so chose to do so. The questions were not connected to any type of advertising or marketing of the product. If there was no response after two weeks, the questionnaire was re-sent. If some of these re-sent questionnaires remained unanswered after two more weeks, no follow up contact was done by the researcher. Only the answers to questions in the returned questionnaires were used in the study.

## Results

Of the dental surgeons certified to use the CVD system, 66.7% bought the CVD diamond tips as seen in Figure 2.

Anesthesia was used in fewer than 30% of cases by 39.3% of accredited professionals (Figure 3). Only 17.9% of professionals never used anesthesia and 14.3% of them always used it in any procedure involving CVDentUS tips. Irrespective of the preparation depth, 47.8% of those interviewed reported the need to anesthetize patients. Of the dentists using the tips for cavity preparation, 44.44% used the tip in fewer than 30% of cases. The CVDentUS tips were always used by 14.81% of those interviewed (Figure 3).

With regard to vibration and noise, 62.5% of those interviewed affirmed patients felt slight sensitivity and 21.9% reported absence of sensitivity (Figure 4).

The final form of preparation was considered more conservative by 48.4% of those interviewed when these tips were used. However, 25.8% considered them to be more invasive, and 25.8% of dentists found the preparation performed with the CVDentUS tip was similar to the conventional diamond tip as indicated in Figure 5.

With regard to the CVDentUS tip wear or less cutting efficiency over time, 55.6% of dentists reported there was no damage to the tip after use and 44.4% reported wear and fracture problems (Figure 6).

A little over half of the professionals (58.6% used them very little and in specific cases) and 27.6% of those interviewed made intensive use of the material and considered them to be durable (Figure 7).

The majority of professionals (78.5%) showed to be satisfied with the acquisition of the instrument. However, with the objective of establishing a relation between the degree of satisfaction of acquiring the tips and problems with their durability, the final form of preparation and the need for anesthesia is shown in Figure 8.

Of the valid responses, six dentists were satisfied with the CVD tips in spite of having reported wear and/or fracture problems. Eleven professionals considered the use of the system to be more conservative when compared to the preparation method using rotary instruments. Five reported the tip creates more invasive preparations, and six described the preparation as similar to those done with a conventional diamond tip. In the opinion of three dentists who were dissatisfied with the purchase of the tips, the CVDentUS system was considered to provide a more invasive preparation than the conventional method.

Of the dentists satisfied with their purchase of the tips, nine used anesthesia in 30% of the cases, six anesthetized from 30% to 60% of cases, five never used anesthetic, and only one reported its use in all cases. Of the dissatisfied dentists, two always anesthetized patients and one uses anesthetic in fewer than 30% of cases.

1. Did you purchase the CVD system tips?  yes  no

2. Have you had any problem with any CVD tips?  yes  no  
If **yes**, state which: \_\_\_\_\_

3. Do you use CVD tips for cavity preparation?  always  
 between 60% and 80% of cases  
 between 30% and 60% of cases  
 in fewer than 30% of cases  
 never

4. Do you use anesthesia in patients when you use CVD tips?  always  
 between 60% and 80% of cases  
 between 30% and 60% of cases  
 in fewer than 30% of cases  
 never

When you use anesthesia, was it due to the great depth of the preparation?  
 yes  no

5. What do the majority of patients report with use of CVD tips in relation to vibration and noise?  
 high sensitivity  slight sensitivity  absence of sensitivity

6. What is the final form of preparation, how does it compare with those obtained with high speed diamond tips?  
 more conservative  similar  more invasive

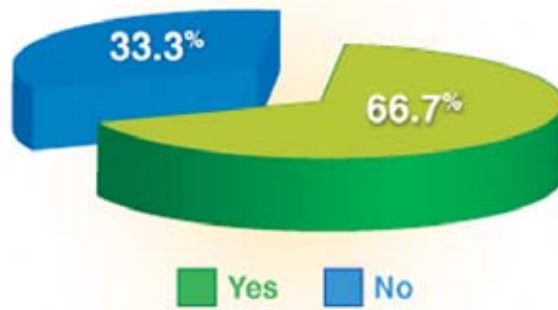
7. Have you observed wear or less cutting effectiveness of CVD tips over a period of time?  
 yes  no  
If **yes**, what was the time of use before failure occurred? \_\_\_\_\_

8. If the tips did not wear or fracture, is it because:  
 you don't use them  
 you make little use of them, and in specific cases  
 you make intense use of them, but they are durable

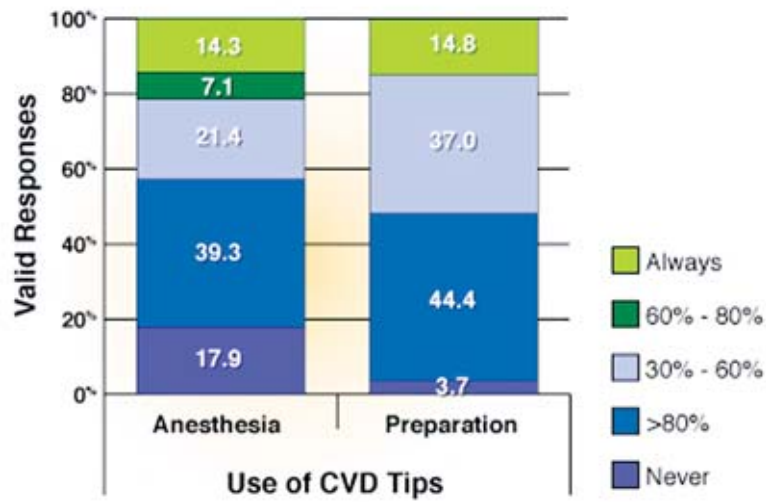
9. Are you satisfied with the purchase of CVD tips?  yes  no

10. Remarks:

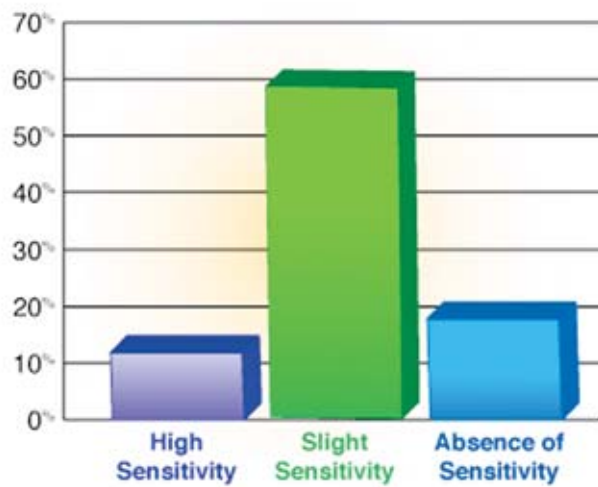
Figure 1. Questionnaire sent to professionals certified in the use of the CVD system.



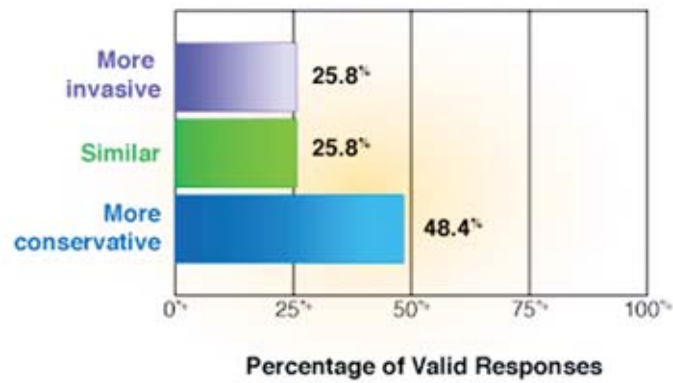
**Figure 2.** Percentage of purchase of tips after being accredited by the CVD system.



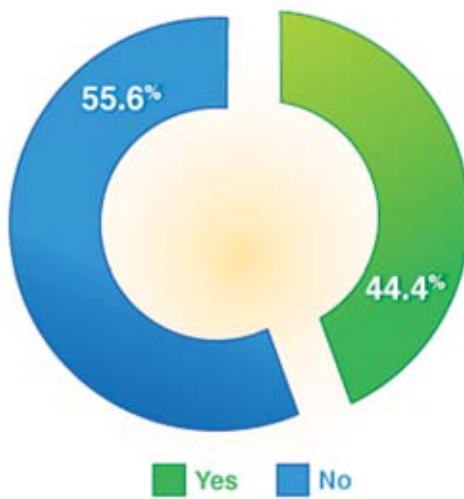
**Figure 3.** Pattern of use of CVDentUS tips according to type of clinical procedure.



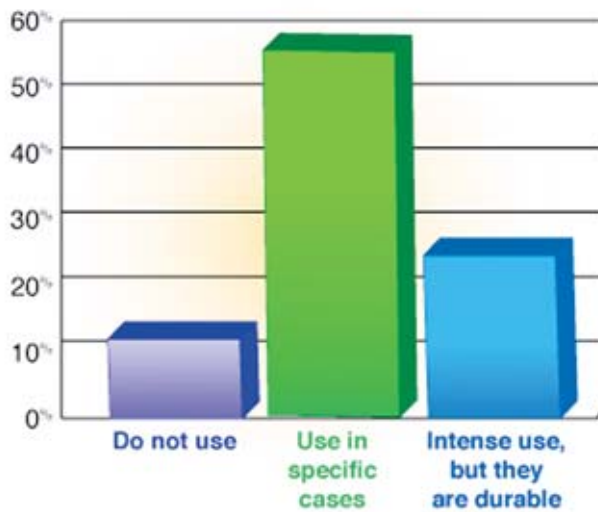
**Figure 4.** Percentage of sensitivity in relation to vibration and noise.



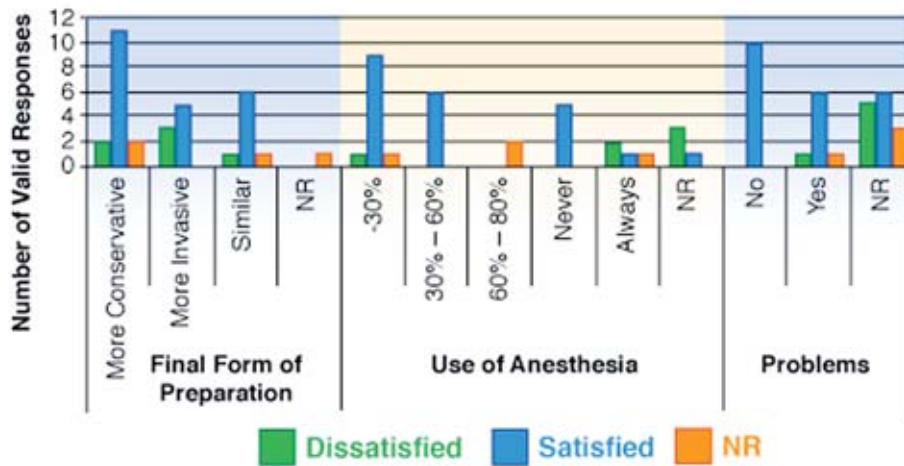
**Figure 5.** Final form of preparation with CVDentUS tips compared to conventional diamond tips.



**Figure 6.** Percentage of deterioration of CVDentUS tips.



**Figure 7.** Ratio of maintaining the integrity of the CVDentUS tip.



**Figure 8.** Relation between satisfaction with purchase of CVDentUS tips and the final form of preparation, use of anesthesia, and problems with the use of the tips.

### Discussion

The use of questionnaires as experimental methodology, according to Vieira and Hossne<sup>6</sup>, is an established method of collecting data because of its use in opinion and pre-election polls. In the health area questionnaires are used when the data can only be obtained by means of the researcher putting questions to whoever is able reply to them. In the present study these are dentists certified to use the CVD system.<sup>3</sup>

Analyzing the percentage of dentists who did not purchase the CVDentUS tips (33.3%), the cost of the equipment must be considered for it is approximately 30 times more expensive than a conventional tip. Manufacturers justify the high cost due to the high durability of the product and the long period for the growth of the artificial diamonds during the fabrication process. Furthermore, there is a lack of data in the literature to support the advantages of the product and make dentists more secure with regard to the effectiveness and efficacy of CVDentUS tips.

With regard to the use of the tips in cavity preparation, 81.4% of professionals use the tips in up to 60% of cases. This suggests the system may be used for the removal of small carious lesions or small restorations. Alternatively, it may be used in conjunction with other cavity preparation methods such as chemical-mechanical ones used in larger restorations. In spite of not having been the object of this study, it is possible CVDentUS tips are being used for

apprehensive patients who might accept the minor vibration associated with ultrasound than the significant vibration of high and conventional speed handpieces.

Some dentists believe their use is limited due to their low cutting speed compared to the high speed handpiece. Consequently, resin removal and performing extensive restoration procedures requires more time.

Problems reported with CVDentUS tips may have originated because of improper use of the product such as using inadequate or higher power than recommended by the manufacturer which may cause fatigue and de-lamination of the CVD diamond.<sup>7</sup> A greater application force reduces the cutting ability of the tip and may lead to fracture of the molybdenum substrate. In addition the lack of irrigation of the ultrasound instrument on the treated surface may cause the tip to heat up and fracture.

An *in vitro* study was done by Borges et al.<sup>8</sup> to assess the wear of CVDentUS tip surfaces and conventional diamond tips using scanning electronic microscopy. Using electronic microprobe analysis, the presence of residues was found on both tips after use on a glass surface and on human teeth. This demonstrated substances like nickel and silicone, among others, were found. In addition there was a significant loss of the diamond particles from conventional

tip surfaces. This did not happen with CVDentUS tips which were shown to be more efficient in cutting ability and to have greater longevity.

In another study Valera et al.<sup>9</sup> showed a substantial loss of the amount of diamond from the conventional diamond tips after 50 perforations on a glass surface. However, no fractures or loss of grains were found on the CVD diamond tips until a thousand perforations were made. In spite of these promising results this study showed 44.4% of the professionals consulted reported problems with the system with regard to tip wear, fracture, and low cutting speed.

The majority of certified dentists (58.62%) reported the tips did not fracture or wear due to their low use rate. One of the possible causes may be justified by the difficulty of adapting to a new working method as well as the low cutting speed. Because the ultrasonic appliance is piezoelectric, the dentist is directed to make "forward" and "backward" movements while keeping it in constant contact with the tooth under slight pressure. This differs from the high speed handpiece which is manipulated with pendulum movements over tooth structure. Such a painting or pendulum type movement with the ultrasound actually retards the cutting effect. However, it may be suggested dentists who make frequent use of CVD tips and report their durability probably acquired sufficient command of the technique for using the equipment.

With regard to the final form of cavity preparation, use of CVD tips was considered to be more conservative (48.4%) or similar (25.8%) to cavity preparation with rotary instruments which corroborates the Vieira and Vieira<sup>2</sup> study. Since use of CVD tips is a procedure demanding more preparation time, the dentist may find gradual removal of the carious tissue or restorations desirable without the unnecessary removal of healthy tissue.

With regard to the problem of pain and discomfort to the patient, only 17.8% of dentists did not use anesthesia when carrying out preparations

with CVD tips. The dissatisfaction of some users who still need to anesthetize patients, may be linked to the manufacturer's marketing campaign claiming anesthesia is unnecessary in the majority of restorative procedures. On the other hand, Balamuth<sup>5</sup> and Postle<sup>10</sup> approached various aspects of the application of ultrasound in dentistry. They emphasized there is a reduction in the heat generated in the pulp due to a reduction of tip friction in contrast to high or low-speed rotary instruments. This creates the possibility for less discomfort and high acceptance by patients. From this aspect, 15.6% of those interviewed reported patients presented with high or slight sensitivity (62.5%) during cavity preparation. According to Franco<sup>7</sup> a factor leading to the need for anesthesia during procedures could be the production of micro-shocks due to the transmission of electrical current to the tooth in treatment rooms without the electrical supply properly grounded which in turn causes tooth sensitivity.

### Conclusions

In spite of the questions raised in this experiment requiring further investigation and in light of the few studies in literature able to justify the results, it is important to know the opinion of dentists certified in the use of the CVD system in order to improve techniques and maximize the benefits to patients.

As a result of this study, the following conclusions can be stated:

1. The CVD system seems to be used for cavity preparation by the majority of certified dentists because it is a more conservative method than high speed handpieces.
2. The majority of dentists use local anesthesia during restorative procedures using CVD tips because the patients still feel pain.
3. CVD tips would seem to present limitations with regard to cutting effectiveness and wear.
4. The majority of certified dentists were shown to be satisfied with the acquisition of CVD tips.



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