

## Minimally Invasive Dentistry Using Sonic and Ultra-sonic Devices in Ultraconservative Class 2 Restorations

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### Abstract

**Aim:** Within the context of minimally invasive dentistry this article describes the sonic and ultrasonic cavity preparation techniques and assesses their advantages and disadvantages, clinical difficulties of their use, and offers a statement about these devices.

**Background:** Ultra-conservative Class 2 restorative techniques require the use of devices such as sonic and the new ultrasonic preparation systems. These systems, featuring a series of sonic and new ultra-sonic inserts, allow for the fabrication of preventive preparations on proximal surfaces without injuring the adjacent proximal surface or damaging the marginal ridge.

**Review:** An ultraconservative approach to the restoration of teeth with proximal caries that lack frank occlusal cavitation is facilitated by the use of slot-style cavity preparations created with sonic and ultrasonic instrumentation, and esthetic restorative materials.

**Summary:** New restorative procedures appear suitable for use in ultraconservative restorative dentistry. More frequent use of these procedures by dental practitioners could prevent the traditional breakdown of the marginal ridge when preparing a Class 2 dental restoration. When cautiously used, these two ultraconservative devices

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provide alternative operative procedures to treat carious lesions without frank occlusal cavitation and to promote another aspect of preventive dentistry.

**Clinical Significance:** New restorative procedures appear suitable for use in ultraconservative restorative dentistry. More frequent use of these procedures by dental practitioners could prevent the traditional breakdown of the marginal ridge when preparing a Class 2 dental restoration.

**Keywords:** Sonic insert, ultrasonic insert, Class 2 restoration, minimally preventive restorative dentistry

**Citation:** Koubi S, Tassery H. Minimally Invasive Dentistry Using Sonic and Ultra-sonic Devices in Ultraconservative Class 2 Restorations. J Contemp Dent Pract 2008 February;(9)2:155-165.

## Background

Dental caries are an infectious disease resulting in lesions that affect enamel, dentin, pulp, and even cementum if the root portion of the tooth is involved. Caries are accompanied by tissue changes in the affected primary dentin and an inflammatory reaction in the pulp.<sup>1</sup> The development of a carious lesion is an intermittent cause of demineralization interspersed with remineralization. Under unfavorable conditions, the progression of the lesion is referred to as an active lesion with dull, white enamel and a soft, yellowish dentin.<sup>2,3</sup> However, under favorable conditions including dietary intake, accurate excavation of the infected tissue, cariostatic sealed restorations, or even with an incomplete removal of the carious dentin<sup>4</sup> and good oral hygiene the process may be reversed and is referred to as arrested caries, even in the deep part of the lesion.<sup>2,3,4,5</sup> In the case of Class 2 lesions, depending on the size and pulp proximity of the lesion, different types of caries extension have been described.<sup>6</sup> The main goal and difficulty is to accurately remove all the infected dentin in a complex shaped cavity<sup>7</sup> without injuring sound dentin and pulp, while preserving the marginal ridge. Traditional restorative procedures and even conservative preparations using Class 2 shaped ultrasonic inserts and proximal ceramic inlays can often lead to extensive loss of healthy enamel and dentin.<sup>5</sup> The traditional Class 2 restoration usually leads to a reduction of stiffness of the teeth of around 30%<sup>8</sup> and dramatically increases the difficulties of the restorative procedure. Obtaining acceptable contact areas with adjacent teeth becomes a great challenge regardless of what high viscosity dental composite or type of matrix system is used.<sup>9</sup>

A variety of strategies have been employed to minimize or eliminate microleakage in Class 2 restorations. These strategies include the use of the following:

- Light-focus-tip polymerization devices<sup>10</sup> which concentrated the light on the ends of the optical fibres<sup>10</sup>
- Incremental filling methods using self-cure or flow composite, etc.<sup>11</sup>
- Decoupling techniques<sup>12</sup>
- Several soft or pulse delay polymerization devices<sup>13</sup>

All of the above have been identified as strategies that increase the marginal seal and the degree of conversion of different composite resin restorative materials, but none have gained universal acceptance. This is mainly due to the variability in the methods used and the results achieved in clinical and *in vitro* studies which prevent a useful meta-analysis to compare results which in turn reduces the value of the individual restorative methods studied.<sup>14</sup>

Changes in restorative techniques such as the use of sonic<sup>15</sup> and new ultrasonic preparations could partly prevent these problems and facilitate the use of ultraconservative restorations for proximal carious lesions reaching the first third (size 1) or the middle third (size 2) of the dentin.<sup>6</sup> Both techniques, ultrasonic and sonic, are useful in minimally invasive procedures. These devices look similar and other devices could be used with them (e.g., air-abrasion, ozone treatment, photoablation, antibacterial therapy, etc.).<sup>16</sup> This review was undertaken to evaluate the clinical advantages and disadvantages of sonic and

ultrasonic insert devices to prepare and excavate dental tissues in ultraconservative Class 2 restorations without breaking the marginal ridge.

### Sonic Devices

The sonic insert system (Sonicsys System, Komet, France) is ergonomically designed, consisting of an autoclavable aluminum cassette and a selection of different semi-circular metallic inserts (Insert numbers: SF 30-31-32-33) with one inactive smooth face free of diamond abrasive (Table 1). The inserts are held in a water cooled handpiece (Kavo 2000, KaVo Dental GmbH, Biberach/Riss, Germany) that emits sonic vibrations (Power 2: 6000 Hertz, amplitude of oscillation: 160  $\mu$ m). The inserts are selected by the defined angularity of each insert and the working proximal site (mesial or distal surfaces). Others inserts are available to bevel the enamel margins (Insert numbers: SF28-29) as listed in Table 1 and Figure 1.

The advantages and disadvantages of the sonic system are shown in Table 2.

Figure 2 shows a clinical sequence of a semi-circular sonic insert in use and the prepared tooth being restored with a composite resin.

Figure 3 shows a clinical sequence of a PrepAngle<sup>®</sup> sonic insert in use and the prepared tooth being restored with a composite resin using a lingual approach.

### Ultrasonic Devices

The new ultrasonic system (Piezo Cavity System, EMS, Switzerland) is also ergonomically designed, consisting of an autoclavable aluminum cassette and a selection of semi-circular metallic inserts of different types with one inactive smooth face free of diamond abrasive. The inserts are held in a water cooled ultrasonic handpiece that emits ultrasonic sonic vibrations (above 20,000 Hertz). Other inserts are available to bevel the enamel margins and to specifically prepare Class 2 lesions with frank cavitation as listed in Table 3 and Figure 1a.

The advantages and disadvantages of the ultrasonic system are shown in Table 4.

**Table 1. Sonic inserts used for slot cavity.**

<b>SONICSYS micro</b>	SF 30-31-32-33 SF28-29	N° 30 à n°33 semi-circular sonic insert. N° 28-29 circular sonic inserts.	For slot and tunnel cavities.
<b>SONICflex bevel</b>	SF58-59	Semi-ellipse sonic inserts.	Used to bevel the preparation.
<b>SONICflex angle</b>	SF53-54	90° sonic prepangle insert	For tunnel cavities.
<b>SONICflex line</b>	TC : SF71-72	Multiple blade inserts.	To eliminate the infected dentin.



**Figure 1A.** Ultrasonic inserts.



**Figure 1B.** Semi-circular sonic inserts. (with their respective EMS and Kavo system handpieces)

Table 2. Advantages and disadvantages of a sonic cavity preparation system.

Advantages	Disadvantages
<ul style="list-style-type: none"> <li>• Preservation of the adjacent proximal surface.</li> <li>• Preservation of the marginal ridge (Figures 2b-2f).</li> <li>• Low risk for enamel fracture.<sup>15</sup></li> <li>• 90° angle tips are available: PrepAngle® (Insert Numbers: 53-54) (Figure 3b).</li> <li>• Constant hand pressure is necessary to have a maximal effect.</li> </ul>	<ul style="list-style-type: none"> <li>• Requires a specific water cooled handpiece (Kavo™ 2000).</li> <li>• Requires an air pressure of about 44 psi (3 bars).</li> <li>• An initial penetration of the enamel with diamond burs to start the cavity is often required.</li> <li>• The outer layer of carious dentin is best removed with a round steel bur mounted in a low-speed handpiece, or with manual excavators.<sup>18</sup></li> <li>• The efficacy of the multiple blade insert (Insert Numbers: SF 53-54) is unknown (Figure 5)</li> <li>• The effectiveness of the device depends on the hardness of the dental tissue.</li> <li>• Perfect filling of the cavity remains difficult to control.</li> <li>• High cost system.</li> <li>• The thickness limit of the remaining marginal ridge is unknown.</li> </ul>



Figure 2A. Proximal caries lesion on the first upper molar.



Figure 2B. Sonic preparation with semi-circular sonic inserts.



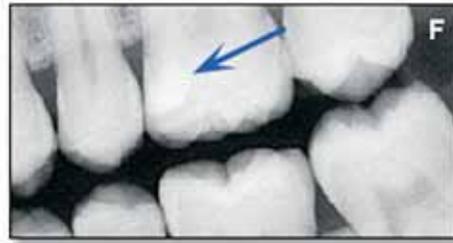
Figure 2C. Disinfection of the affected dentin with a chlorhexidine solution.



Figure 2D. Filling the preparation.



**Figure 2E.** Final restoration.



**Figure 2F.** One year post-restorative radiograph.



**Figure 3A.** Distal proximal lesion on the lower premolar.



**Figure 3B.** Sonic Prepangle® insert in action with caries detector and Carisolv® (chemo-mechanical solution).



**Figure 3C.** Filling the preparation.



**Figure 3D.** Final restoration.



**Figure 3E.** Post-restorative radiograph of control.

**Table 3. Ultrasonic inserts used for slot cavity.**

<b>Inserts SBd and SBm</b>	Semi-circular inserts free of diamond abrasive on one side. SBd: distal cavity SBm: mesial cavity
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**Table 4. Advantages and disadvantages of an ultrasonic cavity preparation system.**

Advantages	Disadvantages
<ul style="list-style-type: none"> <li>● Preservation of the adjacent proximal surface.</li> <li>● Preservation of the marginal ridge.</li> <li>● Uses the same ultrasonic handpiece used for periodontal scaling.</li> <li>● Need for initial penetration with diamond burs to start the cavity is required less often.</li> <li>● Low cost.</li> </ul>	<ul style="list-style-type: none"> <li>● Information concerning the potential to create enamel cracks due to the ultrasonic vibrations and their clinical outcomes is not provided by the manufacturer.</li> <li>● The outer carious dentin is better removed with a round steel bur mounted on a low-speed motor or with manual excavator.</li> <li>● Perfect filling of the cavity remains difficult to control.</li> <li>● The thickness limits of the marginal ridge remains unknown.</li> <li>● Preservation of the adjacent proximal surface is more difficult than with the sonic device with regard to effectiveness of the ultrasonic vibrations.</li> <li>● There are fewer US inserts available, but their average size is smaller making them more useful in very small cavities.</li> <li>● The effectiveness of the device depends on the hardness of the dental tissue.</li> </ul>

Figure 4 shows a clinical sequence of an SB ultrasonic insert instrument in use. (distal or mesial) and the prepared tooth being restored with a hybrid resin ionomer using a vestibular approach.

Like the sonic device the surface of the cut dentin is covered by a smear layer (Figure 6). In the absence of any conditioning the affected carious dentin left on the cavity walls is recovered by a thick smear layer. As a result, conditioning or modifying the nature of this dentin with either a one- or two-step adhesive system remains useful.

For both sonic and ultrasonic techniques, the funnel shape of the “slot” cavity is similar, with the design intended to preserve the proximal contact during both the preparation and excavation procedures. A butt-joint is the usual marginal shape of the cavity, but a slight bevel

on the enamel cervical margins can be realized depending on the accessibility to the caries lesion. The use of a caries detector dye<sup>7</sup> (e.g., Caries Detector, Kuraray Co. LTD, Tokyo, Japan) in combination with a new chemomechanical system<sup>20</sup> for caries removal (e.g., Carisolv, Mediateam, Sävedalen, Sweden) could help reduce the risk of leaving infected tissue. Considering the lack of visibility, which is the greatest difficulty to be resolved when using this kind of restorative procedure, this strategy could also help to reverse the caries process in conjunction with a well sealed restoration (Figure 3).

**Clinical Procedure**

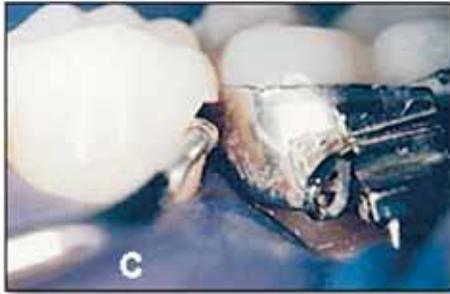
The steps used for both the sonic and the ultrasonic are very similar. Both techniques employ the use of rubber dam isolation to control salivary contamination and to force the interdental papilla away from the preparation area. A small



**Figure 4A.** Distal proximal lesion on the lower premolar.



**Figure 4B.** Initial restorative radiograph.



**Figure 4C.** Ultra sonic insert in use.



**Figure 4D.** Conditioning the affected dental tissue with a self etching adhesive.



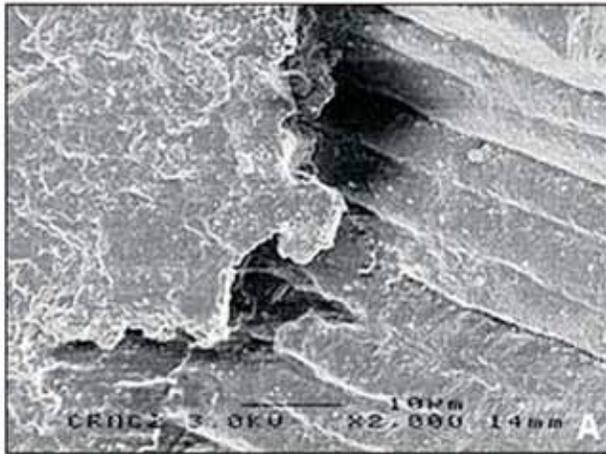
**Figure 4E.** Ultra sonic insert in use.



**Figure 4F.** Final clinical situation (Fuji II, LC was used as a restorative material).



**Figure 4G.** Immediate post-restorative radiograph of the control.



**Figure 6A.** SEM image of smear layer on the dentin sample after the ultrasonic device without any conditioning.

stainless steel matrix is placed between the carious proximal surface and the adjacent tooth to protect the opposite proximal surface. The operative technique is as follows:

#### Cavity Preparation

Preparations are always started with micro burs (Komet France SA, Paris, France) to reduce the time of preparation. Once the cavity has been initiated semicircular-shaped inserts are used in the ultrasonic or sonic handpiece to create the shape of the slot cavity. Any remaining infected carious tissue is eliminated in a traditional manner with a round steel bur mounted in a conventional speed handpiece, or with a spoon excavator. Micro excavators such as the Hu-Friedy, Kotschy excavators, Exckot 4, or Exckot 6 can be used to avoid any marginal ridge fracture (Hu-Friedy Mfg. Co., Inc., Zweigniederlassung, Germany).

#### Matrix Placement

A circumferential matrix cannot be used because of the need to have access to the opening of the slot preparations; therefore, the matrix must be open to allow access and used along with a plastic wedge. A plastic wedge is chosen instead of a wooden wedge because it is more effective in separating the adjacent teeth. The wedge is often stabilized with a light cured liquid dam (Opaldam, BISCO, Inc., Schaumburg, IL, USA) (Figures 5, c, d, and e), which is commonly placed on the opposite side of the opening of the cavity preparation along with a stainless steel matrix (e.g., Palodent Matrix system,



**Figure 6B.** Multiple blade sonic insert to excavate the infected carious dentin.

Darway, San Mateo, CA, USA) that is tightened against the adjacent proximal surface to prevent inadvertent bonding of the restorative material to it (Figure 4D).

#### Clinical Procedure

##### Restorative Materials

Restoring conservative preparations of this kind presents challenges such as a lack of access and visibility, a complex shape, and is as difficult as the caries excavation procedure. Because the marginal ridge is preserved and the restorative biomaterial is free from occlusal wear, the use of biomaterials with cariostatic effects like glass-ionomer (e.g., Fuji II, LC or Fuji IX, GC Corporation, Tokyo, Japan) (Figures 5F and 5G), or a composite resin with a low contraction rate (e.g., Inten-S, Vivadent, Schaan, Liechtenstein) (Figure 3c) is warranted to preserve the marginal ridge from the effects of contraction stress.

Both can be used in combination for esthetic reasons when the composite resin is applied to the outer layer of the restoration. To reduce the eventual overflow, a slightly condensable restorative biomaterial with a medium-viscosity seems to work better than a flow biomaterial. In any case, the affected dental tissue that is left for acid-conditioning can be cleaned with an antiseptic solution (e.g., chlorhexidine solution, Cavity Cleanser, Bisco, Itasca, NY, USA) (Figure 4), although the balance between safety, biocompatibility, and the degree of antibacterial



**Figure 5A.** Carious lesions on the mesial and distal sides of the second upper premolar and mesial carious lesion on the first upper molar.



**Figure 5B.** Initial radiograph.



**Figure 5C.** Cavity shape with the ultrasonic device.



**Figure 5D.** Light cured liquid dam (Opaldam) to control the overflow on the opposite side.



**Figure 5E.** Injection of the hydride ionomer.



**Figure 5F.** Filled cavities covered with a semi slow fluoride release agent.



**Figure 5G.** Final control radiograph.

property has not been clearly established.<sup>16</sup> However, a current reference indicates a 2% chlorhexidine solution applied either before or after acid etching did not seem to interfere with the microtensile bond strength of composite resin to the dentin treated with some of the most recent adhesive systems.<sup>17</sup> One way to overcome any uncontrolled moisture in the deep part of the cavity should it occur is to use a self-etching adhesive system. In order to reduce the risk of secondary caries, a semi slow-release fluoride agent, (e.g., Fluor Protector, Vivadent, Schaan, Liechtenstein) can be applied on the surface of the restoration to protect the proximal caries-susceptible tooth surface, and in addition to the benefits of a slow release of fluoride such varnish can recharge the restorative glass-ionomer with fluoride.<sup>20</sup>

### Finishing and Polishing

After removal of excess overhangs of the restorative material, the margins can be finished and polished with metal finishing strips and silicone tips with diamond polishing pastes. In particular, the Profin Directional System (W&H,

Bürmoos, Austria) is an efficient and effective means to contour, finish, and polish marginal excess and overhangs in ultra-conservative restorative restorations.<sup>21</sup>

### Summary

New restoratives procedures appear suitable for use in ultraconservative restorative dentistry. More frequent use of these procedures by dental practitioners could prevent the traditional breakdown of the marginal ridge when preparing a Class 2 dental restoration. Despite some uncertainties,<sup>16</sup> when cautiously used these two ultraconservative devices provide alternative operative procedures to treat carious lesions without frank occlusal cavitation and to promote another aspect of preventive dentistry.

Despite any current individual success of this type of restoration, a multicenter, randomized controlled trial is needed to investigate the long-term clinical outcomes of sonic and ultrasonic conservative restorative techniques regardless of the restorative materials used.

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