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Refining Access Cavities with the Start X Ultrasonic Tips

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ABSTRACT

A correct pulp chamber opening represents the most important step to locate and negotiate the orifices of the root canals. An adequate opening should provide complete removal of the pulp chamber roof and all the interferences to the root canal system like dystrophic calcifications, dentinal neoformations and restorations. Additionally, in endodontic retreatment cases, a proper access cavity preparation should provide the removal of all the obstacles to the root canal system, like obturation materials and resin or metal posts. A proper access cavity preparation requires a good knowledge of pulp chamber anatomy and a careful study of the pre-operative radiographs. The use of the operating microscope, endodontic probes and ultrasonic tips for endodontic use, provide important advantages when refining access cavities, removing calcifications, posts and finding the orifices of hidden canals. To facilitate and optimize the preparation of the access cavities and localisation of the orifices of hidden canals, a new kit of five ultrasonic tips has been recently introduced, the Strart-X Tips. Start-X TIPS show several advantages. The high cutting efficiency and water port technology allow dentists to use the tips at medium power reducing the risk of overheating dentin; removal of posts and calcifications is also facilitated. The microblades in comparison with the diamond coated tips last for significantly more time without any reduction in efficiency whereas the resistance to fracture turns into an economical advantage for the dentist. Finally the “one tip - one application” philosophy will help clinicians to avoid procedural errors like ledges or perforations.

INTRODUCTION

A correct pulp chamber opening, represents the most important step to locate and negotiate the orifices of the root canals. An adequate opening should provide complete removal of the pulp chamber roof and all the interferences to the root canal system like dystrophic calcifications, dentinal neoformations and restorations.

Additionally, in endodontic retreatment cases, a proper access cavity preparation should provide the removal of all the obstacles to the root canal system, like obturation materials and resin or metal posts. Literature describing pulp-chamber anatomy is generally based on photographs or design of teeth with a complete crown and pulp chambers that are ideal for both position and width. Unfortunately many clinical situations like prosthetic crowns, large restorations, occlusal trauma and dystrophic calcification can alter the original anatomy. Ideal access cavity designs in "real" teeth, may lead to dangerous errors related to inadequate or over-aggressive preparations (1). The access cavity design should be adjusted to the anatomic and clinical situation of each tooth. In order to give clinicians reliable anatomic guides for access cavity preparation, Krasner and Rankow in 2004 evaluated the anatomy of 500 pulp chambers of extracted teeth and formulated the following anatomic laws (1):

Fig.1:Pulp chamber of a maxillary first molar demonstrating Krasner and Rankow's (1) law of color change and law of orifice location 1 and 2 (see text).

1.The floor of the pulp chamber is always a darker color than the surrounding dentinal walls. This color difference creates a distinct junction where the walls and the floor of the pulp chamber meet. (Law of color change).

2.The orifices of the root canals are always located at the junction of the walls and floor (Law of orifice location 1).

3.The orifices of the root canals are located at the angles in the floor-wall junction (Law of orifice location 2) (Fig.1).

4. The orifices lay at the terminus of developmental root fusion lines, if present (Law of orifice location 3).

5. The developmental root fusion lines are darker than the floor color.

6. Except for maxillary molars, the orifices of the canals are equidistant from a line drawn in a mesial distal direction through the pulp-chamber floor (Law of symmetry 1).

7. Except for the maxillary molars, the orifices of the canals lie on a line perpendicular to a line drawn in a mesial-distal

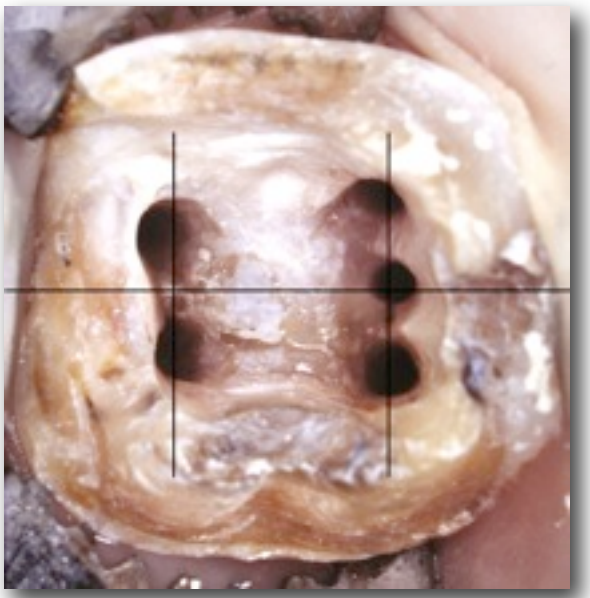

Fig.2: Pulp chamber of a mandibular first molar demonstrating Krasner and Rankow's (1) law of simmetry 1 and 2 (see text).

direction across the center of the floor of the pulp chamber (Law of symmetry 2) (Fig. 2) .

The anatomic laws formulated by Krasner and Rankow (38), should be taken into consideration when opening pulp chambers because they give dentists general anatomic landmarks independent from the crown anatomy that may be very useful to localize the orifices of hidden canals.

A proper access cavity preparation requires a good knowledge of pulp chamber anatomy and a careful study of the pre-operative radiographs. The use of the operating microscope and endodontic probes like the Hu-Friedy DG16 or the JW-17 (C K Dental Specialties) significantly facilitate the inspection of the pulp chamber floor and the finding of canal orifices (1-3). Ultrasonic tips for endodontic use too, provide important advantages when refining access cavities, removing calcifications, posts and finding the orifices of hidden canals.

Two different types of ultrasonic (US) units are commonly used in dentistry: Magnetostrictive and Piezoelectric. Piezoelectric units are generally preferred in Endodontics; they offer more cycles per second (40 kHz), generate less heat and their inserts work in linear, back and forth motion with a vibration amplitude that does not increase linearly with increasing generator power. Several brands of piezoelectric units are available today; all work properly when using tips designed and tuned for each specific generator (4, 5).

Ultrasonic tips for endodontic use are available in different lengths, diameters, angles and designs, with or without water ports. When working with ultrasonic instruments it is important to select a tip with an adequate design to optimize efficiency reducing at the same time the the risk of complications like tip breakage or perforation of the pulp chamber floor. Robust slightly conical tips are indicated to refine the access cavity while thinner tips with rounded non-aggressive ends should be preferred when removing dentin from the orifice of the MB2 or other hidden canals. Conversely, thin US tips with sharp ends are indicated to remove calcification from the pulp chamber and canal orifices always under magnification. Lastly, abrasively coated US tips should be preferred to stainless steel tips when working in the pulp chamber because of their greater cutting efficiency (6,7). Diamond coated tips particularly, were significantly more aggressive than stainless steel and zirconium nitride coated tips in a study by Lin et al., however these tips did show a tendency to break (7). Niobium alloy tips recently invented and patented by Satelec, appear to be a promising material for ultrasonic tips due their biocompatibility, resistance and transmission of ultrasound. Clinically the tips are efficient and do not break but no study is available at the present moment demonstrating their superiority over the stainless steel or diamond coated tips.

Ultrasonic tips for endodontic use provide important advantages when refining access cavities, removing calcifications and finding the orifices of hidden canals. Indeed, their thin, contra-angled and parallel-sided profiles enhance access and vision while their abrasive coating improves precision and cutting efficacy (4, 5). The best results are obtained when ultrasonic tips are used with light brush touch, medium power and under control of the operating microscope (8, 9). Yoshioka et al, (10) found that both magnification and dentin removal under magnification were effective in detecting the presence of MB2 canals. Particularly the authors could detect the MB2 canal in 7% of cases without the microscope, in 18% of cases using magnification and in 42% of cases using ultrasonic tips under the operating microscope (10). Furthermore, the use of ultrasonic instruments under magnification enhances precision and reduces the risk of complications like ledges and perforations (4, 5, 8, 9). To facilitate and optimize the preparation of the access cavities

and localisation of the orifices of hidden canals, a new kit of five ultrasonic tips has been recently introduced, the Strart-X Tips (Dentsply Maillefer).

Fig.3: Start-X ultrasonic tips (Dentsply Maillefer

START-X TIP FEATURES

1- One tip - one application Microblades: The Start-X tips have a cutting surface carachterized by longitudinal rounded micro-blades separated by grooves. This blade design increases efficiency and precision whereas the grooves between the blades facilitate cooling and removal of debris.

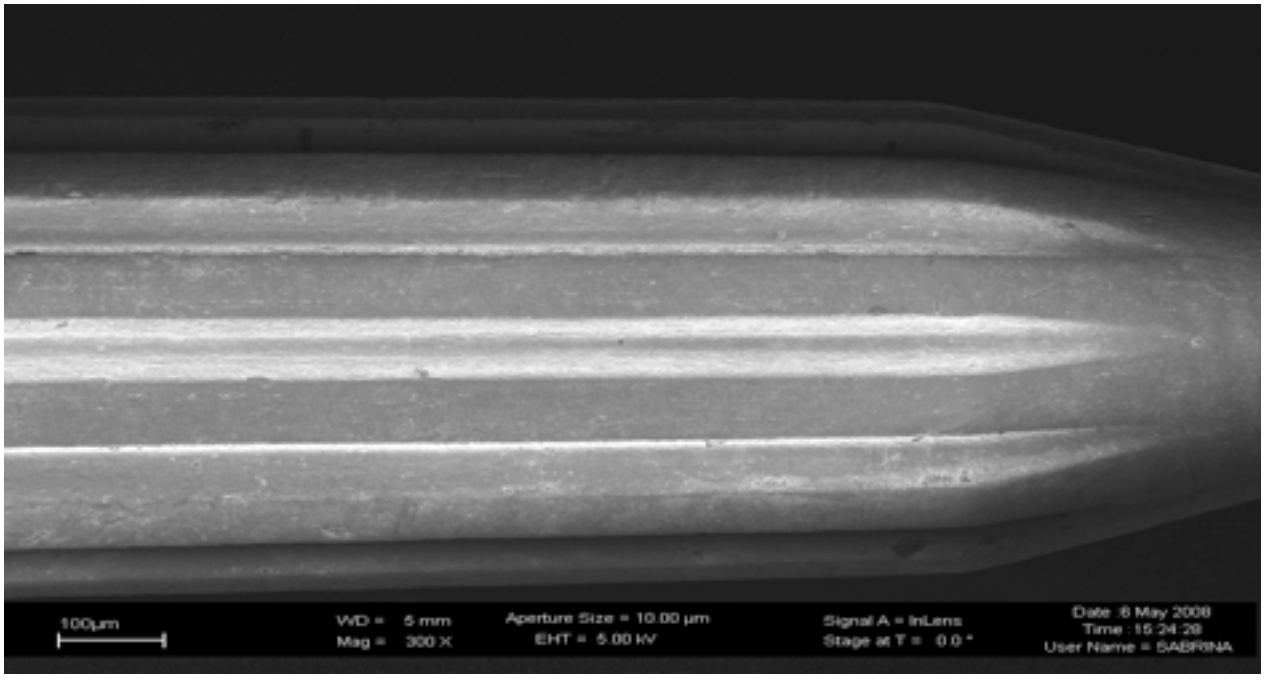

Fig.4: Start-X tip #3 showing on its surface the characteristic micro-blades design (FEG-SEM, SUPRA 40 ZEISS 300X)

In a preliminary investigation on the Start-X tips Berutti et Al. (13) determined that the Start-X tips, after being used on extracted teeth to prepare a cavity with a depth of 1.5 mm, tends to accumulate significantly less debris in comparison with diamond coated tips.

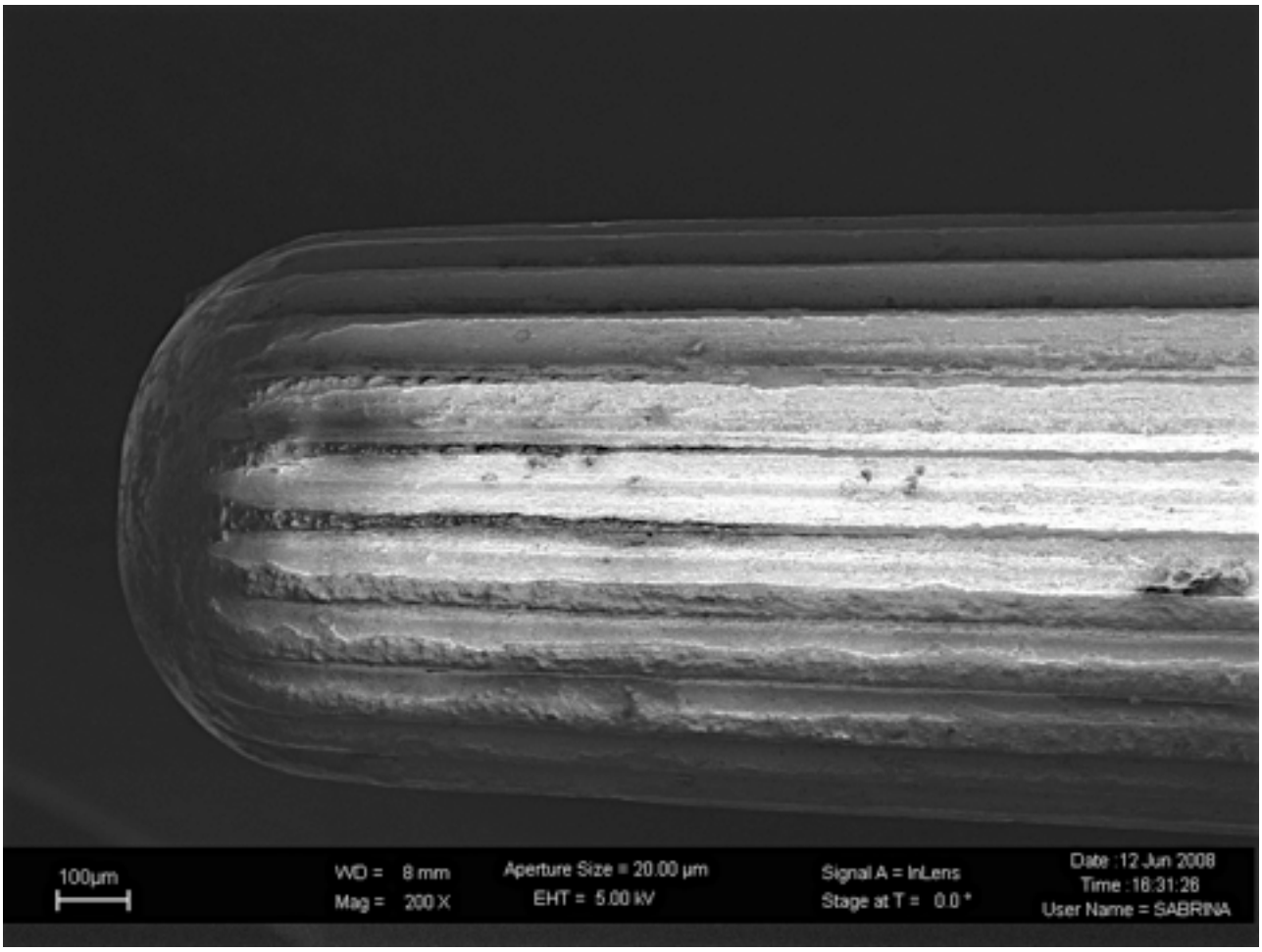

Fig.5: Start-X tip #3 after use do not tend to accumulate significant debris into the grooves between the blades.

2- Water port: The five Start-X tips have water port that allow an effective cooling of the dentin during their use. Ruddle (5) affirms that water port technology in nonsurgical ultrasonic instruments is contraindicated for four important reasons: (a) water decreases tip performance; (b) tips machined for internal water flow become more fragile; (c) there is an undesirable aerosol effect; (d) water in combination with dentinal dust creates mud, lost vision and thereby increases the potential for iatrogenic outcomes. On the other hand, using ultrasonic tips in the pulp chamber without water produces dentinal dust that accumulates on the floor and may hide the canal orifices. In addition, the risk of critical temperature increases on the root surface is significantly higher when US tips are used without water coolant (11, 12). Our opinion is that ultrasonic tips with water port should be preferred; indeed, the intermittent use of the tips with and without water allows a proper cooling of the dentin and adjacent tissues without a significan loss of visibility (10, 11).

3- Resistance to fracture: The Start-X are strong tips; indeed, after long and continuous clinical use, the tips do not show any tendence to breakage or deformation. The high resistance to fracture of the tips should depend, according to Dentsply Maillefer engineers, on the thermic treatments used on the stainless steel alloy during the manufacturing processes.

4-Efficiency: The Start-X tips are very effective when used to cut dentin. We suggest to start cutting with the ultrasonic unit set at medium-low power and increase the powert only in case the tip do not work properly. The Start-X tips should be used with light touch and activated only when they are in contact with the dentin surface. Since the cutting efficiency seems to be reduced when the tips are used with water, we suggest an intermittent activation of the water ports to cool dentin and remove dentinal dust.

5-Precision: In a preliminary report, Beutti et al. (13) compared the Start-X tip #3 with a diamond coated tip (Tufi # 1 San Diego Swiss Machining Inc.) as to their capability to prepare precise cavity on extracted teeth. The results indicated that the Start-X could prepare symmetrical and smooth cavities whereas the diamond tip preparations were significantly more irregular and rough.

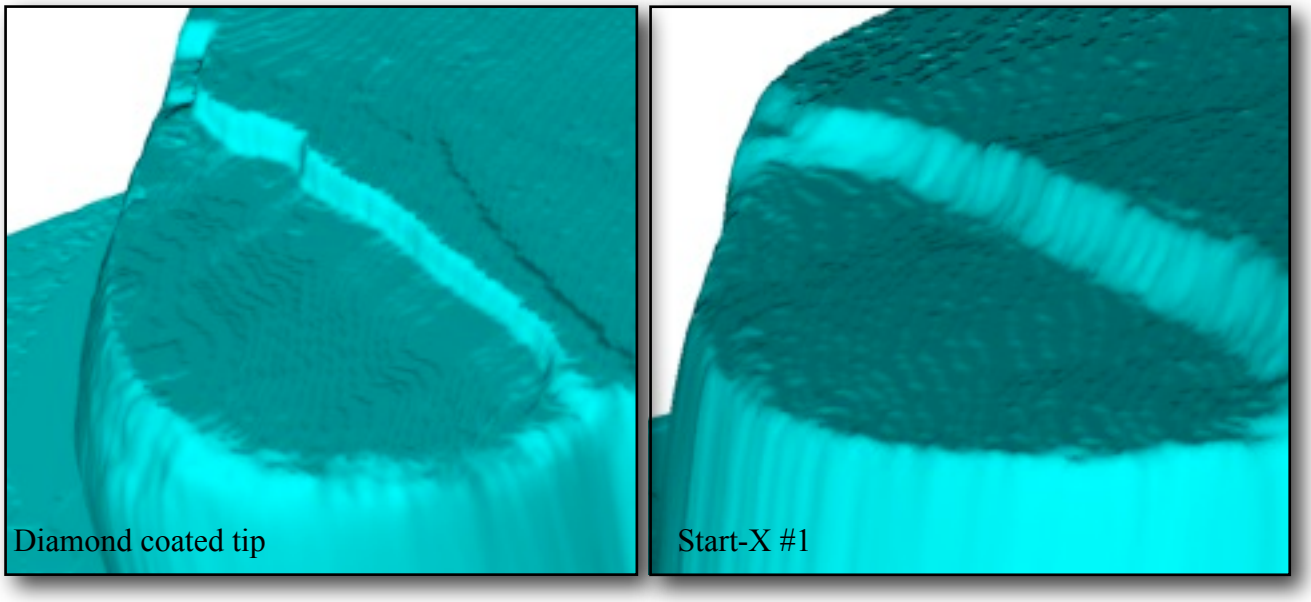

Fig.6: Comparison between a Tufi #1 (left) and a Start X #1 after the preparation of a standard 1.5 mm deep cavity in extracted teeth. The use of the Start-X tip resulted in a significantly smoother and more symmetrical preparation. (13)

6-Good visibility : The Start-X tips are manufactured with an angle of 110° between the shaft and the cutting surface that optimize visibility during clinical use either with the operating microscope or with the naked eye.

7-Tested on the majority of ultrasonic units: The Start-X tips have been tested and work properly with the majority of the ultrasonic units that utilize the Satelec and EMS screw thread.

START-X TIPS: CLINICAL INDICATIONS

Start X tip #1: The Start-X #1 has a diameter at the tip of 0.8mm, a maximum diameter of the active portion of 1.6mm and a distance D1-D2 (blade length) of 12 mm. The microblades do not reach the rounded end of the tip that looks smooh with reduced cutting ability. The main indication for the Start-X #1 is the refining of access cavity walls. Indeed. after the opening of the pulp chamber, the tip can be used to remove restoration and filling materials, caries, and dentin interferences from the access cavity walls thas allowing a direct access to the root canal orifices. This tip is particularly useful in retreatments allowing to obtain perfectly clean and refined access cavities walls whereas the rounded not cutting end minimizes the risk of altering the morphology of the pulp chamber floor .

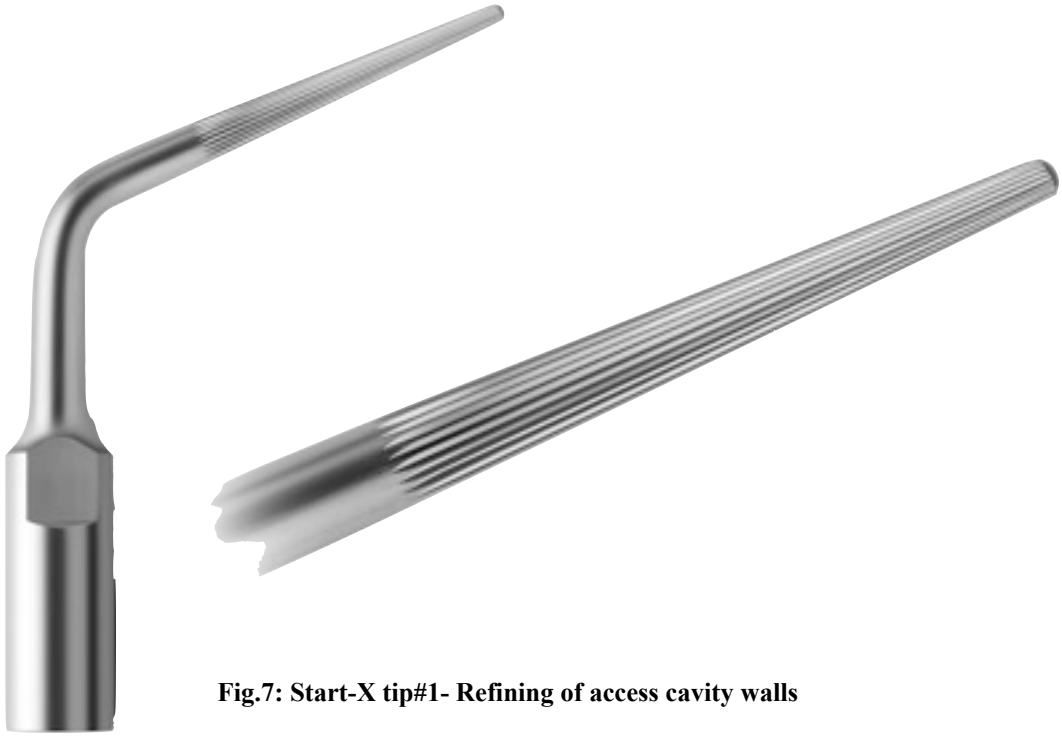

Fig.7: Start-X tip#1- Refining of access cavity walls

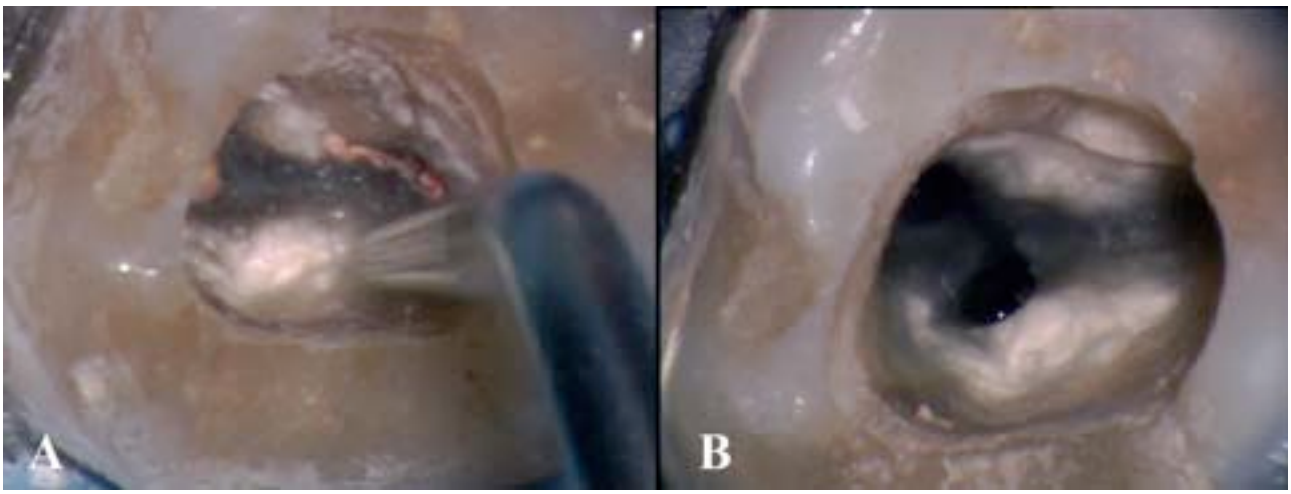

Fig.8: Start-X tip#1used to refine the access cavity in an endodontic retreatment of a maxillary molar. The access cavity before (A) and after the use of the Start X tip#1.

Start X tip #2: The Start-X #2 has a diameter at the tip of 1.0 mm, a maximum diameter of the active portion of 1.54 mm and a distance D1-D2 (blade length) of 8 mm. The microblades extend to the rounded end of the tip thus increasing the cutting efficiency at the end of the tip.

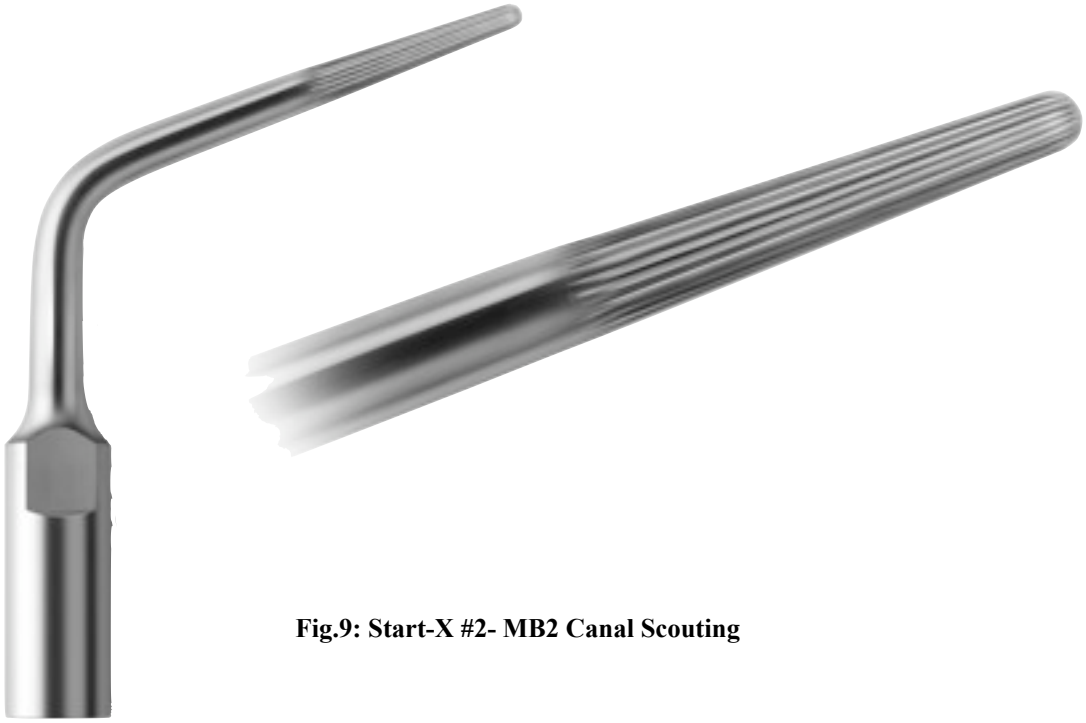

Fig.9: Start-X #2- MB2 Canal Scouting

The main indication for the Start-X #2 is the removal of the dentinal layer in the pulp chamber floor of maxillary molars, between the mesiobuccal (MB1) and the palatal canals, that can hide the orifice of a second mesiobuccal canal (MB2). The maxillary first molar is indeed the tooth that presents the higher risk of missing canals during an endodontic treatment. Cleghorn et al. (14) reviewed the canal configuration in mesiobuccal roots of maxillary first molars in 34 studies (comprising 8399 teeth). Two or more canals were found in 56.8% of the teeth in a weighted average of all 34 studies (14). One canal was found in 43.1% of these roots. A single apical foramen was found 61.6% of the time, while two separate apical foramina were present 38.3% of the time (14). Wolcott et al. (10) reported a great discrepancy between clinical and laboratory results in the incidence of MB2 canals, demonstrating that the MB2 is often not found during the endodontic treatment with higher risk of endodontic failure (10). The Start-X #2 significantly facilitate localization of the orifice of the MB2 canal in maxillary molars; indeed with its active, rounded tip it is easy to create a groove in the pulp chamber floor, 1 to 2 mm. deep, between the MB1 and palatal canals, thus removing all dentinal interferences and allowing the finding of the MB2 orifice with a DG16 probe.

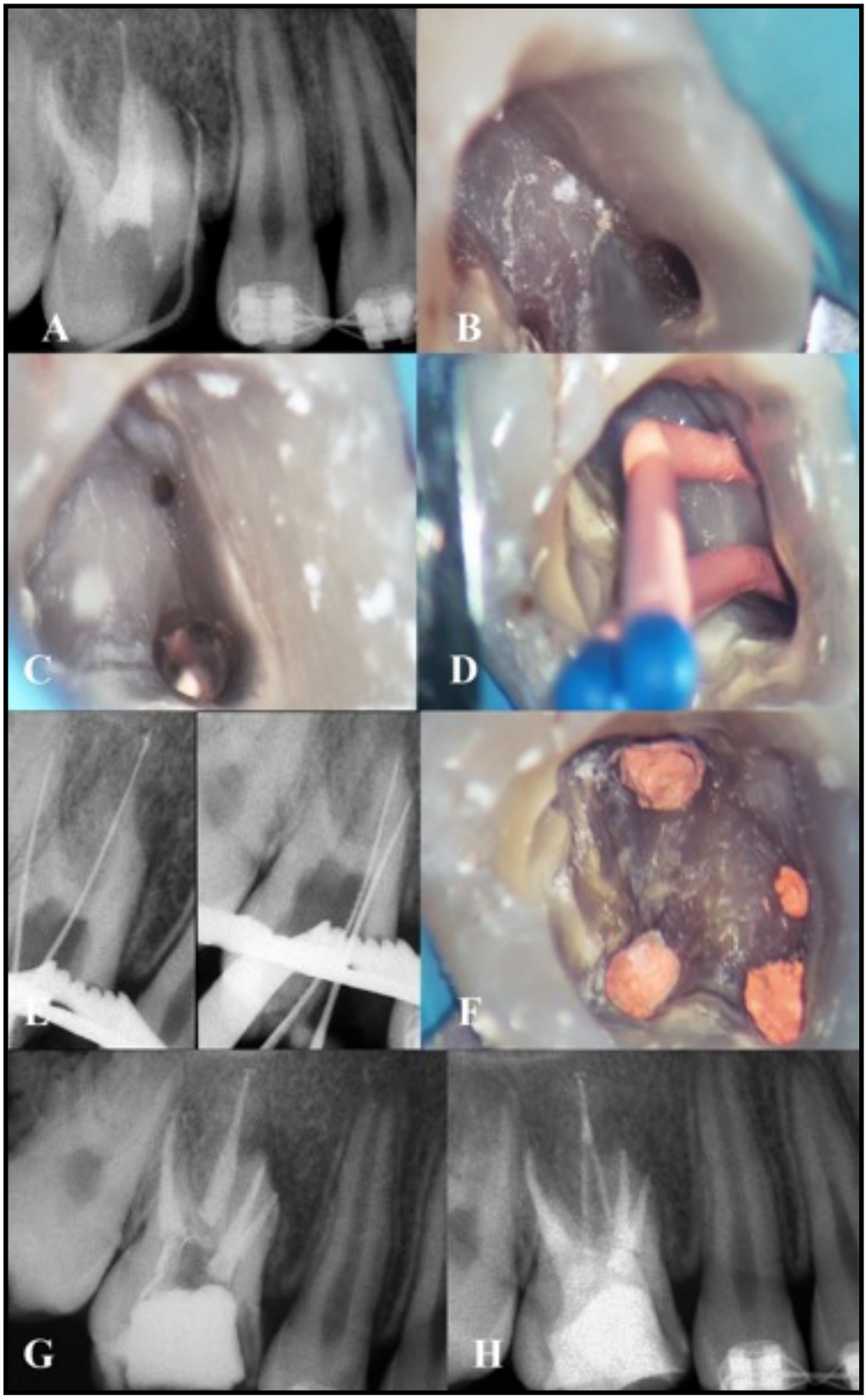

Fig.10: Preoperative radiograph;. The asymmetry of the obturation material within the MB root suggests the presence of an untreated canal (Fig.10 A). The orifice of the MB2 canal is not visible on the pulp chamber floor (Fig.10 B). After the use of the Start-X tip #2 the orifice of the MB2 canal becomes visible (Fig.10 C,D). The four canals are shaped (Fig.10 E) and filled with vertically condensed warm gutta-percha (Fig.10 F,G). A 1 year follow up radiograph demonstrated complete healing of the bone lesion in the mesiobuccal root(Fig.10

Start X tip #3: The Start-X #3 is characterized by a sharp and acuminate end. The microblades, do not reach the end of the tip but stop approx.1 mm before. The diameter of the tip at the base of the end (D1) is 0.64 mm, the maximum diameter of the active portion (D2) is 0.9 mm and a distance D1-D2 is 8 mm.

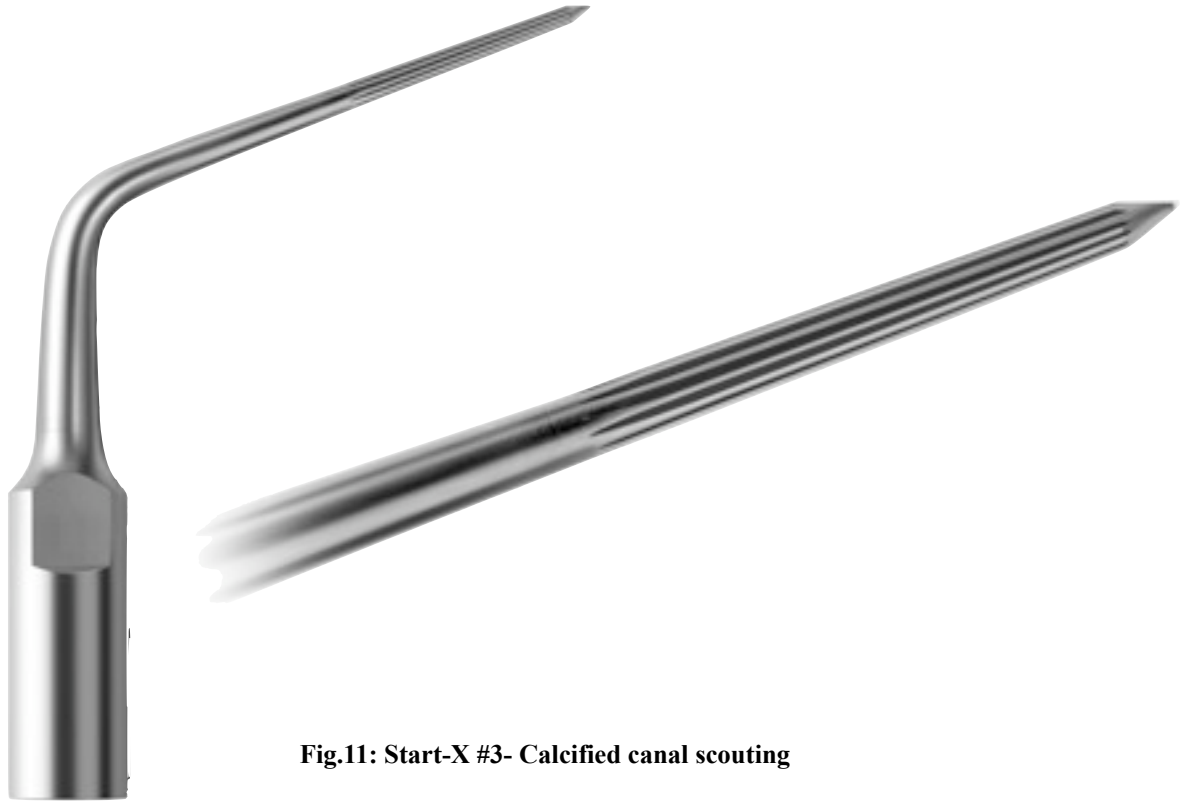

Fig.11: Start-X #3- Calcified canal scouting

The main indication for the Start-X tip is the removal of calcifications from the pulp chamber or from the root canal coronal third. Additionally this tip can be used to remove fiber posts in retreatment cases. The tip is aggressive and should be used always with light touch and medium power and with intermittent activation of the water port.

Fig.11: Use of Start X #3 to remove a big calcification from the access cavity of a maxillary first molar. Preoperative radiograph (11A)

Fig.11 B-E: After the access cavity preparation, the presence of a big calcification is clearly visible (11B). Using the Start X tip #3 the calcification can be successfully removed (11 C-D). Post operative radiograph (11E)

Start X tip #4: The Start-X #4 has a tapered conical shape with a diameter that progressively reduces from 1.24 mm to 0.8 mm. However, at 1.5 mm from the distal end the diameter increases again and the shape changes into a convex triangol shape with a maximum diameter of 1,4 mm and a length of 1.5 mm.

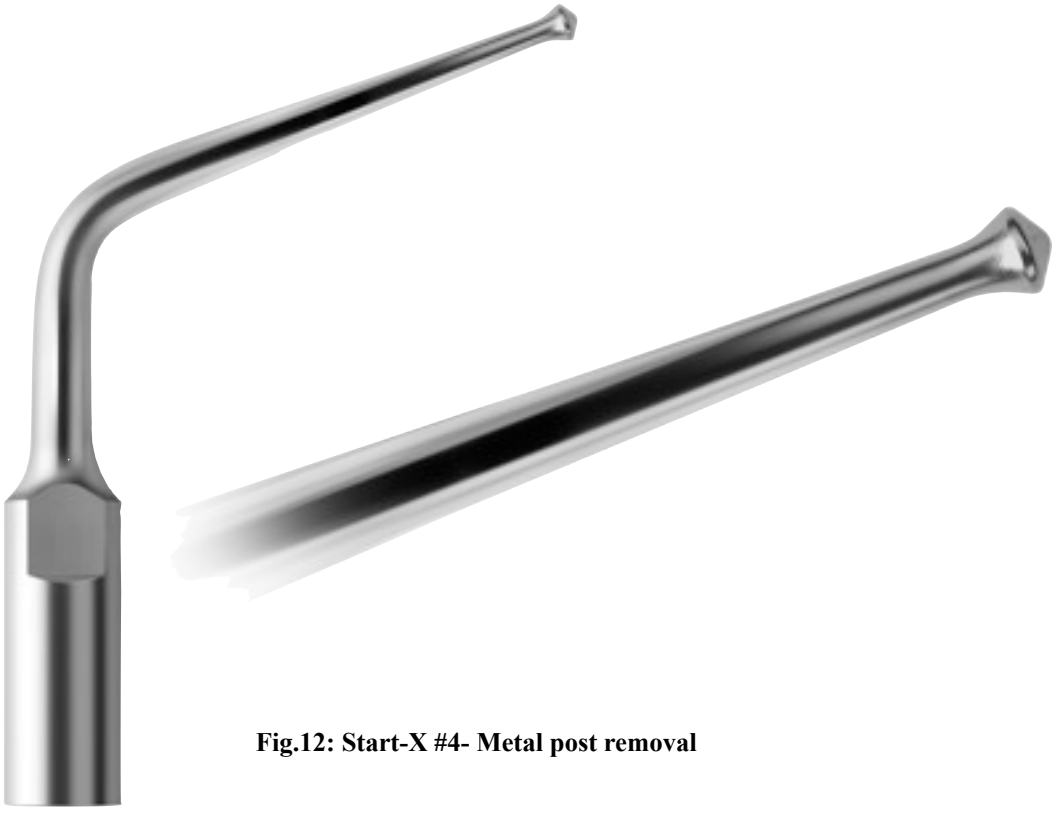

Fig.12: Start-X #4- Metal post removal

The Start-X #4 is indicated to remove both screw or cast metal posts; indeed after having exposed 3-4 mm of the post head, the convex triangular end of the tip can be easily placed even in small undercuts facilitating the dislodging of the post without useless waste of dental tissues. The most active distal end of the ultrasonic tip should be kept in intimate contact with the post to maximize energy transfer and promote cement/bond failure (5). The tip must be moved around the post circumferentially and up and down along its exposed length intermittently activating the water port to decrease heat buildup and the potential for dangerous heat transfer to the attachment apparatus (5). In case of cast metal post/ core, the core must be reduced with high speed diamond burs to facilitate and optimize the use of the tip and the transmission of the ultrasonic energy.

Fig.13: Use of Start X #4 to remove a metal post/core. Preoperative radiograph (13A) and photograph (13B). After the reduction of the core to expose the post (13C), the Start X #4 is used with light touch (13 C-D) until the post can be dislodged (13 E). Post operative radiograph (13 F)

Start X tip #5: The Start–X #5 is characterized by parallel sides with a length of the active portion of 10 mm and a diameter of 1.0 mm. The tips shows, at the distal end, a characteristic concave shape; the microblades reach the end of the tip thus increasing the cutting efficiency at the tip terminus.

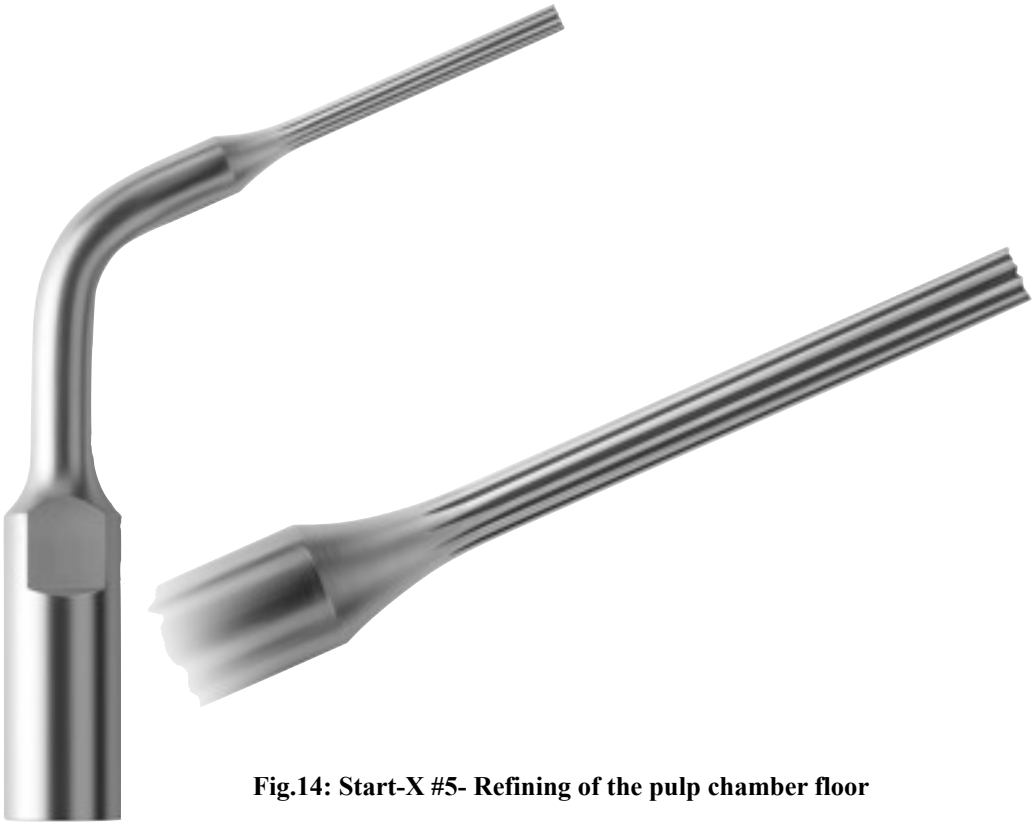

Fig.14: Start-X #5- Refining of the pulp chamber floor

The main indication for the Start-X # 5 is the removal of calcifications from the pulp chamber floor in maxillary and mandibular molars; these calcification should be removed in all cases since they can prevent a direct access to the root canal system and hide pulp debris or/and the orifice of accessory and aberrant canals (16-19). The concave end of the Start-X matchs almost exactly the convexity of the pulp chamber floor of molar teeth facilitating the removal of calcifications without altering the original anatomy that, with development lines, helps to localize the root canal orifices. Furthermore the tip can be used in endodontic retreatments to clean the pulp chamber floor from fragments of old obturation and/or restoration materials (Fig.15 A-B).

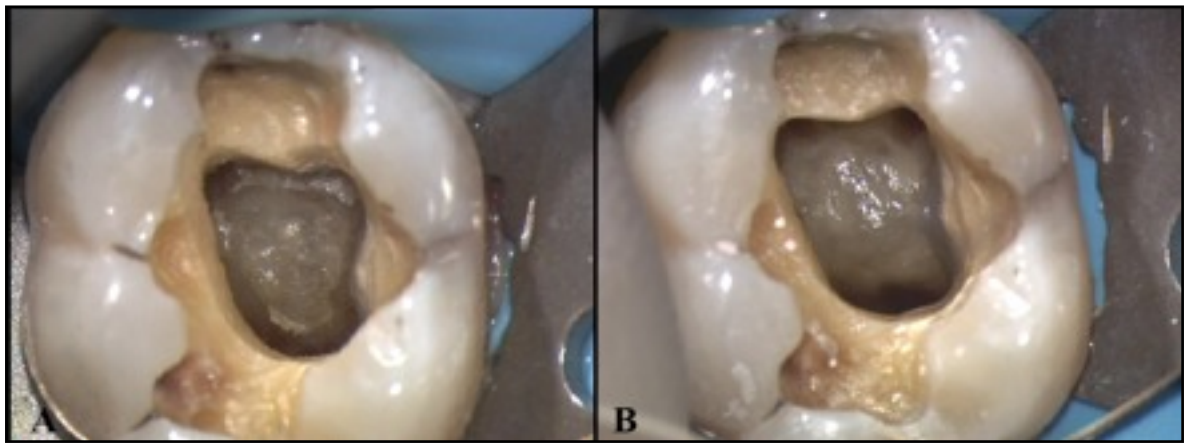

Fig.15: Pulp chamber floor of a mandibular molar before (15A) and after (15B) the use of the Start X tip #5 to remove a calcification and facilitate the access to the root canal system.

CONCLUSIONS

A proper access cavity preparation is of central importance to localize the orifices of the root canals, reducing the risk of missing anatomy during root canal treatments (20). In addition, to find hidden and extra canals, an adequate armamentarium is required; the dental operating microscope will provide enhanced lighting and visibility, whereas ultrasonic tips will allow a controlled and delicate removal of calcifications and other interferences to the canal orifices. Different types of ultrasonic tips are available to refine the access cavity; among them the new Start-X show several advantages. The high cutting efficiency and water port technology allow dentists to use the tips at medium power reducing the risk of overheating dentin; removal of posts and calcifications is also facilitated. The microblades in comparison with the diamond coated tips last for significantly more time without any reduction in efficiency whereas the resistance to fracture turns into an economical advantage for the dentist. Finally the “one tip - one application” philosophy will help clinicians to avoid procedural errors like ledges or perforations.

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