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A new approach to minimally invasive preparation of a crack line on the labial surface of an anterior tooth: A case report

Hidetaka Ishizaki* and Takashi Matsuura**

Department of Periodontology and Endodontology, Nagasaki University Graduate School of Biomedical Sciences, 1-7-1, Sakamoto, Nagasaki 852-8588 Japan

*Corresponding author: Hidetaka Ishizaki, D.D.S., Ph.D.
** Hidetaka Ishizaki and Takashi Matsuura contributed equally to this work.

ABSTRACT

We herein report a new approach for the minimally invasive preparation of a crack line on the labial surface of an anterior tooth using a No. 12d scalpel blade. First, cervical caries on the labial surface were removed using a diamond bur with a high-speed rotary cutting instrument. Next, the stained crack line observed after caries removal was removed with a No. 12d scalpel blade. Minimally invasive preparation of the crack line was then performed with a No. 12d scalpel blade. After caries removal and preparation of the crack line, an adhesive procedure was performed under cotton roll isolation according to the manufacturer's instructions, and the cavity was filled with a flowable resin composite, followed by polishing. An approach using a No. 12d scalpel blade to prepare the crack line on the labial surface of an anterior tooth has not yet been reported. For minimally invasive intervention, we suggest that a scalpel blade is a tooth-friendly instrument for the removal of stains in crack lines and cavity preparation for flowable resin composite restoration.

Keywords: anterior tooth, flowable resin, isolation, manufacturer's instructions

Introduction

Microcracks are sometimes observed on the enamel surface, especially in older patients (Lee, 2011, p. 959-974). Risk factor for enamel cracking have been investigated in a number of studies. Enamel is known to be brittle, and the force applied during mastication or bruxism is considered to be able to cause enamel cracking (Rasmussen, 1976, p. 154-164). An in vitro study showed that low and high temperatures also produce enamel cracks3. Walker et al. identified three types of enamel cracks: cracks without stain, cracks with stain and cracks with shadows cast by transillumination (Walker, 1998, p. 110-116). Microcracks without stain are considered not to have been invaded by bacteria, so fluoride application and follow-up observation are recommended. However, cracks with stain or shadows cast by transillumination can be sites of caries initiation (Walker, 1998, p. 110-116). Riccuci et al. performed a histopathological analysis and showed that some cracks extended to the dentine, allowing bacteria to invade dentine tubules (Ricucci, 2015, p. 343-352). Therefore, cracks with stain or shadows cast by transillumination demand restorative treatment4.

Cracks that extend to the dentine are suspected of causing dentine sensitivity or hypersensitivity (Longridge and Youngson, 2019, p. 44-51). Furthermore, cracks on the molar proximal surface infected by bacteria can sometimes cause the generation of large dentin caries under the intact enamel surface. Contact caries, such as hidden caries, are difficult to detect, so early caries detection with radiography, which is reported to be useful for the detection of hidden caries, is required (Ricketts, 1997, p. 259-265, (Zachrisson, 1980, p. 307-319) Furthermore, when symptoms such as dentine sensitivity or hypersensitivity are reported by patients, transillumination and microscopic examinations are also effective and feasible for recognizing and visualizing microcracks (Walker, 1998, p. 110-116, (Clark, 2003, p. 391-401; discussion 401, (Hasan, 2015, p. 164-168). Optical coherence tomography (OCT) can also create cross-sectional images of translucent or semi-translucent biological structures with microscopic-level resolution without radiation and has been reported to have high sensitivity and specificity, making it an effective modality for detecting caries and enamel cracks (Shimada, 2020, p. 109-118).

A clinical study using transillumination reported that microcracks were most frequently observed on the facial tooth surface, and the most prominent cracks were observed on the maxillary canines and central incisors (Zachrisson, 1980, p. 307-319). Patients sometimes have aesthetic complaints of stained cracks on their maxillary incisors. When aesthetic restoration for multiple teeth, including intact as well as cracked teeth, is required, restoration with a ceramic crown or laminate veneer can be chosen (Cherian, 2011, p. 35-38, (Shenoy and Shenoy, 2010, p. 195-203). However, when aesthetic restoration only for cracked teeth is required, the removal of the enamel cracks with a round bur for microcrack restoration is considered overtreatment, as this approach requires the otherwise intact enamel to also be removed. If cracks are located only on the enamel and the staining of the cracks is slight, the crack line is often not treated, and follow-up observation is instead performed for minimal intervention (Mamoun and Napoletano, 2015, p. 293-303). However, some patients prefer restorative treatment for aesthetic improvement.

We herein report a new approach for the minimally invasive preparation of a crack line on the labial surface of an anterior tooth using a scalpel blade. For aesthetic improvement of the labial surface of a maxillary right central incisor with caries and a stained crack, the caries was removed with a high-speed rotary cutting instrument, and the stained cracks observed after caries removal were removed with a No. 12d scalpel blade. The minimally invasive preparation of cracks on the labial surface was performed with a No. 12d scalpel blade, and the cavity was finally restored with flowable resin composite.

Case Presentation

A 54-year-old female patient had an aesthetic issue concerning her maxillary right central incisor. Staining was observed at the crack line on the labial surface of the maxillary right central incisor, but no subjective symptoms or pain arising in response to thermal or evaporative stimuli were noted. The stain was unable to be removed by dental prophylaxis and was thus suspected of extending into the enamel (Figure 1). Based on the clinical evaluation, a diagnosis of cervical incipient caries was made for her maxillary right central incisor. Two treatment plans were suggested: (1) follow-up observation, or (2) composite resin restoration after removal of the caries and stain along the crack line. She expressed a preference for composite resin restoration.

Caries was removed without anesthesia using a round bur (F-006-XLf; MARYDIA, Hinatawada, Ome, Tokyo, Japan) with a high-speed air turbine and constant water cooling (Figure 2). After caries removal, staining was observed along the crack line of the cavity floor (Figure 3). The stain was planned to be removed because it made aesthetic restoration difficult. Normally, rotary cutting instruments or laser instruments are used for caries removal; however, it is impossible to remove the stain from a crack line without damaging the intact enamel. Thus, in this case, a No. 12d scalpel blade (12d; Feather, Osaka, Japan) was used to remove the stain from the crack line (Figure 4). It was possible to remove the stain from the crack line in this manner without damaging the intact enamel because the No. 12d scalpel blade is quite thin. After the removal of the stain (Figure 5), selective etching was performed for 20 seconds (Ultra-etch J; Ultradent, South Jordan, UT, USA), followed by washing and air-drying with a three-way syringe. After cotton roll isolation, an adhesive procedure was performed with a two-step self-etch adhesive (Clearfil Megabond 11; Kuraray, Tokyo, Japan) according to the manufacturer's instructions. The self-etching primer was applied, left for 20 seconds and dried with gentle air application. A bonding agent was then applied, dispersed with gentle air and light-cured for 10 seconds with an LED curing light in low-power mode (G-Light Prima 11 Plus; GC, Tokyo, Japan). The prepared crack was coated with a high-flow flowable composite (Clearfil Majesty ES Flow; Kuraray) (Figure 6), and the cavity was filled with a low-flow flowable composite (Clearfil Majesty ES Flow; Kuraray) using a thin instrument (Flowable art; Tokuyama Dental, Tokyo, Japan) (Figure 7). The composite resin was then light-cured for 10 seconds with an LED curing light (Figure 8). After filling, polishing was performed with Pogo (Polish go; Dentsply Sirona, Charlotte, NC, USA) (Figure 10 and 11). All procedures were performed under a dental operating microscope (OPM1 Pico MORA; Carl Zeiss, Jena, Germany). The patient remained asymptomatic eight months after restoration (Figure 12).

The list of materials used is shown in Table 1.

List of materials used is described in Table 1.

Material	Manufacturer	
Diamond bur (F-006-XLf)	Hinatawada	Rotary cutting instrument
Scalpel blade 12d	Feather	Scalpel blade
Ultra-etch J	Ultradent	Acid etching agent
Clearfil Mega Bond 11	Kuraray	Adhesive system
Clearfil Majesty ES Flow	Kuraray	Flowable composite resin
G-Light Prima 11 Plus	GC	Light-curing unit
Flowable art	Tokuyama Dental	CR Instrument
Pogo (Polish and go)	Dentsply Sirona	Polishing system
OPM1 Pico MORA	Carl Zeiss	Microscope

Fig.1

Fig.2

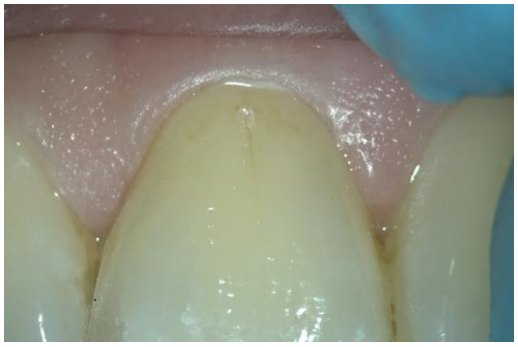

Fig.3

Fig.4

Fig.5

Fig.6

Fig.7

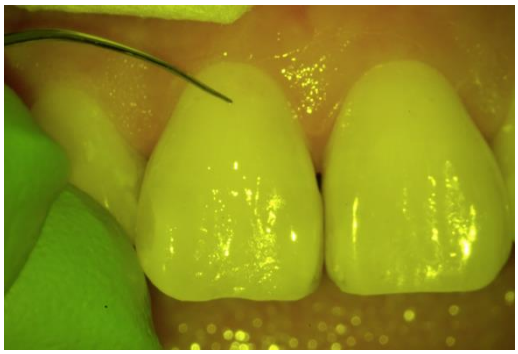

Fig.8

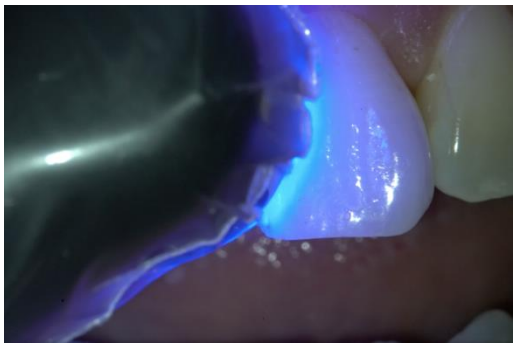

Fig.9

Fig.10

Fig.11

Fig.12

Figure Captions

Figure 1. Caries and staining of the crack line on the labial surface of an anterior tooth. The stain was unable to be removed by dental prophylaxis and was thus suspected of extending into the enamel.

Figure 2. Removal of caries using a round bur. Caries was removed without anesthesia using a round bur with a high-speed air turbine and constant water cooling.

Figure 3. Crack line on the cavity floor. After caries removal, staining was observed in a crack line on the cavity floor.

Figure 4. Removal of stain from crack using a No. 12d scalpel blade.

Figure 5. The stain had penetrated deeply into the crack line.

Figure 6. After removal of the stain from the crack line.

Figure 7. The prepared crack was coated with a high-flow flowable composite and filled with a low-flow flowable composite.

Figure 8. The morphology was adjusted using a thin instrument before curing with an LED curing light.

Figure 9. Filled composite resin was light-cured for 10 seconds with an LED curing light.

Figure 10. Polishing was performed with Pogo.

Figure 11. Post-restoration.

Figure 12. Eight months after restoration. The patient remained asymptomatic eight months after restoration.

Discussion

It is impossible to regenerate tooth substance lost due to caries; therefore, the tooth should be restored with amalgam, composite resin, inlay, onlay or a full-coverage crown. However, retreatment is often required due to dislodgement of restorations or secondary caries. Furthermore, with every retreatment, more tooth substance is lost, and the cavity volume is increased (Fernández, 2015, p. 279-286, (Hunter, 1995, p. 2-6).

The concept of minimal intervention has recently become widely accepted, and more patients now require minimally invasive preparation (Sheiham, 2002, p. 2-6, (Tyas, 2000, p. 1-12, 2017, p. 6-7). However, patients sometimes visit a clinic for aesthetic improvement because of stained cracks on the labial surface of a maxillary anterior tooth. Clinical decision-making concerning whether stained microcracks on the labial surface of an anterior tooth should be treated by damaging the intact enamel or by follow-up observation to avoid the unnecessary removal of intact enamel is difficult for clinicians.

Nd:YAG and Er:YAG laser therapy has been used for caries removal and cavity preparation instead of rotary cutting instruments (Keller and Hibst, 1997, p. 32-38, (Yamada, 2001, p. 239-243, (Kornblit, 2008, p. 81-87). Keller et al. suggested that caries removal with a laser was more comfortable and acceptable for patients than that with conventional rotary cutting instruments (Keller, 1998, p. 649-656). Furthermore, in vitro studies have shown that Er:YAG laser irradiation increased the enamel-acid resistance and adhesive properties, exposing enamel prisms and dentinal tubules with no smear layer on the enamel and dentine surface (Díaz-Monroy, 2014, p. 501357, (Correa-Afonso, 2010, p. 534-540, (Sasaki, 2008, p. 57-61, (Tsanova and Tomov, 2010, p. 46-55).

Scalpel blades are mainly used for soft tissue management in oral and periodontal surgeries. Morgan reported a case in which a No. 12 scalpel blade was used to finish composite resin restoration (Morgan, 2004, p. 211-217; quiz 218). Proper polishing of composite resin restorations is mandatory for the long-term survival, prevention of plaque accumulation and aesthetic improvement of composite restoration (Kup, 2015, p. 228-245). It is difficult to control the finishing movement using a diamond bur without causing intact enamel wear around composite restoration or generating ridges and lines on the tooth surface (Kup, 2015, p. 228-245). However, a scalpel blade has high material-selectivity on the enamel surface and enables clinicians to remove composite resin without also removing the enamel (Kup, 2015, p. 228-245). Therefore, Elaine et al. described a scalpel blade as a more tooth-friendly and easily controllable finishing instrument than a rotary cutting instrument (Kup, 2015, p. 228-245).

As the size of a diamond bur is wider than that of enamel microcracks, intact enamel located near microcracks winds up being removed during these procedures. Furthermore, cavity preparation with regular-grid diamond bur is reported to cause cracks in the marginal enamel (Nishimura, 2005, p. 9-15). However, Feather surgical scalpel blades are made from a stainless-steel sheet with a

thickness of 0.38 mm, and the edge angle is finished between 29°00′ and 38°00′ by shaving both sides of the sheet evenly. Therefore, it is possible to perform thinner preparations and more easily remove microcracks on the labial surface of an anterior tooth and stain from the buccal grooves of molars while damaging less of the enamel by moving along the lesion on a smooth surface than with rotary cutting instruments.

In the present case, caries and stains in crack under the caries were removed, the crack line was prepared, selective etching and adhesive treatment were performed according to the instructions, and the cavity was filled with a flowable resin composite. Because the cavity prepared with a No. 12 scalpel blade was thin and shallow, a flowable resin composite was adequate. Due to the risk of air bubbles being embedded when the low-flow flowable composite was injected into the thin cavity, a high-flow flowable composite was first coated onto the cavity floor of the microcrack using an instrument to avoid generating air bubbles. The low-flow flowable composite was then added and cured.

We herein report a new approach for the minimally invasive preparation of a stained crack line observed after enamel caries removal using a No. 12d scalpel blade. Conventional restoration with composite resin, a laminate veneer or full-coverage crown is effective for teeth with multiple cracks or that require wide-range restoration; however, we propose our approach as a treatment option for a microcrack or patients who prefer minimally invasive preparation. Of note, microcracks management with a scalpel blade requires special care to avoid extending the crack line.

All procedures were performed under a microscope. Dental operating microscopes were introduced in 1982 and are particularly frequently used for endodontic practice (Selden, 2002, p. 206-207). The resolution of the unaided human eye is around 0.2 mm, and it is impossible for most clinicians to see and treat lesions smaller than 0.2 mm. However, a common operating microscope can improve the resolving limit to 0.006 mm (Carr and Murgel, 2010, p. 191-214). Thus, a microscope or surgical loupe is necessary for the treatment of microcracks.

The interface between the enamel and composite resin restoration is suspected to be stained at long-term follow-up after microcrack restoration with flowable resin composite filling; therefore, long-term follow-up observation that includes polishing is required.

Conclusion

The approach we introduced in this report has potential utility for cases in which follow-up observation or conventional restoration with damaging intact enamel are performed. However, more cases and longer-term follow-up are required for confirmation of the utility of this approach.

Conflict of Interest

The authors of this manuscript certify that they have no proprietary, financial, or other personal interest of any nature or kind in any product, service, and/or company that is presented in this article.

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