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Clinical Observation of the Effects of CAD/CAM Glass-Ceramic Onlay in the Restoration of Mandibular Second Molar

Lin Qing[1], Xu Jing[2*]

[1]Department of Endodontics, Jinan Stomatological Hospital, China

[2]Department of stomatology, Shengli Oilfield Central Hospital, China

[*]**Corresponding author:** Xu Jing, Department of stomatology, Shengli Oilfield Central Hospital, China

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Abstract

The objective of this study is to evaluate the clinical effects of the CAD/CAM glass-ceramic onlay in the restoration of a mandibular second molar with distal caries. The method involved 56 endodontically-treated molars that were restored with CAD/CAM glass-ceramic onlays after a single-visit root canal treatment. The effects were evaluated after 6, 12, 18 and 24 months by one-experienced clinicians in accordance with the modified USPHS criteria at baseline. The follow-up after two years showed teeth recovery. Satisfactory effects were observed in marginal adaptation, tooth integrity, color match, surface roughness, gingival inflammation, retention, and proximal contact. There were notable failures in three cases: two onlays were extracted and one was fractured. In conclusion, using CAD/CAM glass-ceramic onlays is an effective treatment for the restoration of permanent molars with serious caries.

Keywords: C-Shaped canal; Intramedullary fixation; Mandibular second molar; Root canal therapy; CAD/CAM Glass-ceramic onlay

Introduction

After a root canal treatment, mandibular second-molar teeth change physical, chemical, and physiological characteristics. They become less drop-resistant and more prone to tooth fracture. The CAD/CAM glass porcelain onlay repair can make full use of pulp chamber retention, which prevents the loss of tooth tissues and makes it easier for surgery to avoid cutting flesh, in order to make an digital dental impression. Once-recovery teeth are restored to their original anatomical shape, which makes patients more comfortable and reduces the stimulation to the tooth tissue. In this study, the CAD/CAM vitreous porcelain onlays were used for repair, and their clinical efficacy was evaluated and analyzed.

Method

From July 2013 to September 2015, 52 patients (28 male and 24 female) with chronic pulpitis developed from the caries of the distal- and middle-adjacent teeth of the second molar of the lower jaw were treated in the Dental Department of Jinan Stomatological Hospital. There were a total of 56 affected teeth. Patient ages ranged from 19 to 53. The average age was 31. Based on the x-ray images of the distal caries and medulla of mandibular second molar, inclusion criteria required that there be no obvious root tip shadow, loose tooth, knock pain, and abnormal gums. The patient must have a normal mouth opening, a cooperative attitude, treatment tolerance, and no history of systemic diseases or drug allergies. All of the affected teeth were treated with a single-visit root canal. Informed consent was signed before surgery.

Equipment

CEREC 3D (Siemens, Germany); VitaMark Ⅱ porcelain pieces (Vita company, Germany); NX3 Nexus Third Generation Dual-Cure Resin Cement (Kerr corporation, United States).

Clinical operations

Part A: Tooth preparation

After one week of root canal treatment, if the patient with the affected tooth is diagnosed as having no discomfort, the glass ion temporary seal can be removed, and the root canal mouth closed with a flowing resin so that it forms a continuous and smooth plane with the bottom of the pulp. The thin tip is removed so that the thickness of the shaft wall is greater than 1.5mm. In the preparation process, in order to match the thickness of the onlay with the thickness of the bite space between the upper and lower teeth, a bite registration must be performed using a wax mold. The axial plane degree of polymerization should be 6°-8°. It is important to avoid concavity. There must be an obtuse angle point line, rather than an acute angle edge. For transparent rows gum line available in far gum or high frequency electrical knife gum bleeding, be sure to clear the edge line.

Part B: Making onlays

The digital dental impression is taken inside the mouth. The CEREC3D system will automatically generate the prosthesis, do design and repair, connect the grinding equipment, select the right porcelain block for colorimetry and fix it, and make the glass-ceramic endo-crown, which together takes about 15-20 minutes.

Part C: Trying onlays

First, carefully examine the adjacent relation of onlays and edge tightness, as well as their grind and wear. Next, treat the tooth surface for 60 seconds with 35% phosphoric acid, then 60 seconds with 5% hydrofluoric acid on the insert tissue surface. Afterwards, rinse, dry, and then do occlusal adjustment and polish.

Part D: Observing the standard

Patients were told to return to the clinic once every six months after treatment for the clinical effect to be reevaluated using the USPHS standard (Table 1). After two years of review, seven items were evaluated, including: marginal adaptation, tooth integrity, color match, surface roughness, gingival inflammation, retention, and proximal contact. Those that conform to standard A are considered to be successful, so their success rates were calculated.

USPHS criteria	Alpha	Bravo	Charlie
Marginal adaptation	continuity at the margin (no ledge or ditch)	slight discontinuity detectable with explorer but not requiring replacement	excessive wear with dentin exposure requiring replacement
Tooth integrity	complete integrity	enamel split or crack	cusp/tooth fracture
Surface roughness	smooth	rough	loss of material
Color match	no mismatch to the adjacent tooth structure	slight mismatch but clinically acceptable	esthetically unacceptable mismatch
Gingival inflammation	none (healthy)	Slight	severe
Retention	present	partial loss but clinically acceptable	Clinically unacceptable partial loss or absent
Proximal contact	physiological	far & too weak	traumatization of gingiva (food impaction)

Table 1: Modified USPHS criteria [1,2].

Result

All 56 affected teeth were successfully reevaluated according to the improved USPHS standard (Table 2). Six months after surgery: It can be seen that the dental integrity, edge tightness, color matching, restoration retention, gingival condition, adjacent relation, and broken porcelain have all reached grade A standard. One year after surgery: One case had a slightly loose onlay, and floss was easy to pass through. One case had slight inflammation of the gums, and a small amount of bleeding was detected. One patient had visible cracks on the edge of the onlay. In another case, onlays fell off, which was re-bonded by medical staff. The affected tooth did not fall off during subsequent follow-ups. One year and six months after surgery: In one case, onlays fell off and were re-bonded. In one case, 37 onlays were broken into porcelain pieces on the side of tongue. One patient still had visible cracks on the edge of the onlay, and had poor contact with the tooth body. In one case, the onlay was slightly loose, and the floss was easy to pass. Two patients had slight inflammation in their gums due to poor oral hygiene. Another case was slightly different only in the color and translucency of the adjacent teeth. Two years after surgery: One patient had visible cracks on the edge of the onlay. Another case was slightly different only in the color and translucency of the adjacent teeth. For the previous two reviews, the loose onlays of the adjacent points were found to have food tamponade. Additionally, there was an old filling in the middle of the proximal mandible of the first molar of the lower jaw. The adjacent relation was not good, so the old filling was removed, the resin formed sheet was added, and the composite resin was filled again. Patients were advised to review their teeth regularly and pay attention to proper oral hygiene.

Items	level	Results of different evaluation periods (n = 56)			
		6 months	12 months	18 months	24 months
Marginal adaptation	A	56 (100.0)	55 (98.2)	54 (96.4)	55 (98.2)
	B	0 (0.0)	0 (0.0)	1 (1.8)	1 (1.8)
	C	0 (0.0)	1 (1.8)	1 (1.8)	0 (0.0)
Gingival inflammation	A	56 (100.0)	55 (98.2)	54 (96.4)	55 (98.2)
	B	0 (0.0)	1 (1.8)	2 (3.6)	1 (1.8)
	C	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Proximal contact	A	56 (100.0)	55 (98.2)	55 (98.2)	55 (98.2)
	B	0 (0.0)	1 (1.8)	1 (3.6)	0 (0.0)
	C	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.8)
Colour match	A	56 (100.0)	56 (100.0)	55 (98.2)	55 (98.2)
	B	0 (0.0)	0 (0.0)	1 (1.8)	1 (1.8)
	C	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Surface roughness	A	56 (100.0)	56 (100.0)	55 (98.2)	56 (100.0)
	B	0 (0.0)	1 (1.8)	0 (0.0)	0 (0.0)
	C	0 (0.0)	0 (0.0)	1 (1.8)	0 (0.0)
Tooth integrity	A	56 (100.0)	56 (100.0)	56 (100.0)	56 (100.0)
	B	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Retention	A	56 (100.0)	55 (98.2)	55 (98.2)	56 (100.0)
	B	0 (0.0)	1 (1.8)	1 (1.8)	0 (0.0)

Table 2: Clinical observation of CAD/CAM glass ceramics onlay in the restoration of mandibular second molar [n (%)].

Discussion

This study selected the VitaMark II glass-ceramic piece for its good biocompatibility, good chemical acid corrosion, hydrofluoric acid treatment of the rough surface of the adhesive, Nexus Third Generation Dual-Cure Resin Cement binder to tooth tissue that has cohesive force, perfect retention force, and compression wear-resisting. In addition, the CAD/CAM glass-ceramic onlays can be operated by the side of the chair at a single time to reduce the number of patients' visits. It can also take 3D digital dental impression in the mouth to avoid the discomfort of a pallet-making impression during the repair. It is simple, accurate and comfortable, improving patient satisfaction and reducing doctor-patient disputes (Figure 1).

Figure 1: Three cases treated by CAD/CAM glass-ceramic onlays in the restoration of mandibular second molar after root canal treatment (修复前：Before treatment; 修复后：After treatment；病例：Case.)

The gap formed between the proximal- and middle-adjacent surface of the mandibular third molar and the distal-adjacent surface of the second molar is prone to food impaction, resulting in the distal caries of the mandibular second molar, which can affect the distal- and middle-adjacent maxillofacial and subgingival root surface. Chronic pulpitis is commonly seen in clinical practice. After a single-visit root canal treatment of the mandibular second molar, doctors suggest also pulling out the impacted mandibular third molar. This will be more conducive to the maintenance of oral health by preventing the embedding of food. One week after the CAD/CAM glass-ceramic onlays restoration, most patients are ready for the removal of the mandibular third molar. However, for diabetic patients with an unstable blood sugar level, removal of the mandibular third molar requires signed informed consent, consultation about their potentially-adverse situation, general oral health education, and regular review for three months. It is advised that the mandibular third molar not be removed until after high blood sugar has been lowered (blood glucose levels must be within 88mmol/L).

The anatomical structure of mandibular second molars is special because of its distance between the distal and middle gums, which means the incidence of a c-shaped root canal is about 24-31.5%. After complete root canal therapy [3,4], the traditional post-core crown can be repaired, but the root canal is prone to excursion or lateral perforation, leading to root bifurcation lesions, root fracture, etc. The excessive tooth tissue needs to be trimmed for better retention. However, the glass-ceramic onlays can instead restore the connection adjacent to the first mandibular molar by reducing the tooth structure, preserving the anatomical shape of the original tooth, and giving slight stimulation to gingival tissue [5]. The anatomical structure of the root tip of the c-shaped root canal is complex and variable. If the root canal is blocked or bent because of calcification, it can be dredged by micro-ultrasonic technique. If root canal treatment fails, then root tip surgery will be more complex, meaning that the onlays will be more conducive to the c-shaped root canal re-treatment than the traditional post-core crown [6]. High embedding can make full use of the fixation effect of the pulp cavity without needing to prepare the pile-track. Doing so reduces operation time, better preserves the seal of the filling in the root tip, and prevents root canal migration or side penetration.

The concept of minimally invasive restoration in oral treatment has added new vitality to traditional stomatology [7]. In the past, post crowns can be used to deal with the insufficient residual amount of crown tooth tissue in full crown restoration after root canal therapy [8]. The inlays of medullary cavity retention avoid the risks of lateral root canal penetration, root fracture and post fracture that may occur during post canal preparation [1]. Zou Gaofeng, et al. [2] believed that minimally invasive treatment of demulpinated teeth should include minimally invasive treatment of root canal therapy (reducing excessive cutting of the periodontal dentin on the basis of ensuring the establishment of linear access), as well as minimally invasive repair of inlays retained in the pulp cavity [9,10]. The premise of minimally invasive restoration of onlays is that the remaining teeth have sufficient resistance and retention [11].

In this study, the first step of root canal therapy is to simultaneously remove the necrotic cavity and prepare the tooth body so as to reduce the crown height of the tooth, lift the top of the pulp, fully expose the pulp cavity, and facilitate root canal recovery. Because the mandibular second molar is in the tooth column on the furthest end (close to the root of the tongue and multiple mucosa transition), dental body preparation can be an inconvenient operation because of the poor visual field and narrow space. It can be easy to damage the surrounding soft tissue. Additionally, it is difficult to prepare for the traditional post-core crown restoration because patients need to keep their mouths wide open for a long time, which can be uncomfortable. The improved tooth preparation is more simple and convenient because the operation time is greatly shortened, the edge tightness of the insert is improved, the occurrence of microleakage and secondary caries is reduced, and the preparation forms a plane parallel to the occlusion surface so that the high insert body can get enough resistance. The degree of densification between the implant and the tooth is one of the important factors affecting the success of the repair. During clinical operation, attention should be paid to the optimal design of the gingival wall to reduce the concentration of stress in the gingival wall and microleakage at the neck edge; the cavity preparation to prevent the occurrence of lateral force; and the buffer stress area to avoid jaw interference caused by the prosthesis, the formation of a steep tooth tip, and the fracture of the tooth [12]. CAD/CAM glass-ceramic onlays are carefully ground and polished, making it difficult for plaque to adhere to its surface, which reduces the occurrence of gingivitis in the second molar of the lower jaw [13].

After one year of repair with CAD/CAM glass-ceramic onlays, only in one case did the onlay fall off. In this case, it was re-bonded at reexamination after a year and a half. The re-fixation was good after at the reexamination after two years. Analysis of this case revealed that the onlays were not tightly closed, the cavity type of the pulp was too shallow and fixed, and the outspread angle was too large, which could not as effectively isolate moisture. In another instance, the one-year review found that one of the thirty-seven cases had a tiny crack in its maxillofacial glass-ceramic onlay. After a year and a half, the inlay mesial lingual chunk had collapsed. The tooth was then once again prepared using glass-ceramic onlays. The follow-up review showed that the edge seal retention is good. The reason for this near-collapse may be that the maxillofacial preparation height of this tooth was not enough (less than 2 mm). In addition, overbite and underbite are also factors. In a final instance, one case out of the forty-seven involving glass-ceramic onlays showed in its one-year and year-and-a-half reviews a slightly loose adjacency. As a result, dental floss passed through more easily. Despite gum swelling, there was no obvious appearance of food. At the two-year review, examination revealed

in the mandibular first molar the presence of old maxillofacial filling and poor adjacency relations between the old filling on resin molding and the composite resin filling.

In this study, 56 affected teeth were observed at the follow-up after two years. Good clinical results were achieved in edge densification, color matching, gum condition, and adjacency relationship. The main reason for these good results is that all of the affected teeth have been treated with perfect root canal therapy, meaning that the glass-ceramic onlays can make full use of the pulp chamber as the retention cavity, which greatly strengthens the retention of the implant. CAD/CAM all-ceramic upper inlays with preparation holes increase the binding force and friction between the crown and insert. With modern bonding materials and technology, the high bonding strength of the NX3 generation dual-cure resin cement can improve the bonding strength of materials.

Conclusion

In this study, out of 56 affected teeth, the shortest time it took to evaluate the curative effect was one year. Some of these effects can be observed after two years. In these cases, the efficacy was satisfactory at the second visit. However, the long-term effect of all affected teeth remain to be further observed with an expanded sample size. Overall, our study concludes that using CAD/CAM glass-ceramic onlay to repair the c-shaped root canal with mandibular second molar is efficient, successful, and worthy of clinical application.

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