A report on the clinical use of bonding systems for coronal restorations produced from CAD/CAM resin blocks

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Computer-aided design and manufacturing (CAD/CAM) resin-produced restorations were approved by a health insurance system in Japan from the year 2014. In this study, we investigated the use of CAD/CAM resin blocks in Japan since 2014, and the clinical use of adhesive systems for CAD/CAM resin-produced restorations in dentistry. Our findings indicated a rise in the clinical application of these products; however, some studies have reported instances of debonding and fracture of the restorations. CAD/CAM resin blocks were implemented in the health insurance system in Japan as an alternative for alloys due to the continuous rise in the prices of gold and palladium. Thus, in order to reduce the number of failures in CAD/CAM resin-produced restorations due to debonding and fracture, the integration of these restorations with the tooth structures is of utmost importance.

Keywords: Dental materials, CAD/CAM resin block, Dental adhesive system, Demand and supply, Research study

INTRODUCTION

Restorations produced from computer-aided design and manufacturing (CAD/CAM) resin blocks have been covered by health insurance in Japan for the past six years. These materials are currently used in both premolars and molars. Several dental manufacturers sell CAD/CAM resin blocks, but quantitative details about their demand have not been well-documented. Furthermore, various resin cements have been sold by manufacturers since the approval of the use of CAD/CAM resin blocks by the insurance system; nonetheless, several cases of debonding have been reported in the literature1-3).

Herein, we have reviewed the overall use of CAD/CAM resin blocks in dental practices in Japan and the clinical use of adhesive systems for restorations fabricated from these blocks.

ADVANTAGES OF CAD/CAM RESIN BLOCKS

The fabrication of composite crowns using CAD/CAM resin blocks was approved by the health insurance system in Japan in 2014. These resin blocks are stable and possess high strength owing to the polymerization of the matrix resin with filler particles under conditions of high temperature and pressure. According to the Japan Dental Material Association, restorations used for premolars must have a flexural strength of 100 MPa or more, and those for molars require a flexural strength of 240 MPa or more after 7 days of storage in water4). However, the published mechanical strengths of CAD/CAM resin blocks differ among manufacturers5,6), causing some confusion in the selection of these blocks during treatment planning. In addition, due to the minute amounts of unpolymerized monomers in the blocks, the bonding to this material remains a challenging task7).

Pretreatment of the intaglio surface before bonding and the use of an adhesive resin cement are mandatory because adhesion to filler particles similar to bonding to ceramics is required in their clinical use8-10).

The benefits of the introduction of CAD/CAM resin blocks for patients include superior esthetics, good shade matching in indirect restorations, and the possibility of avoiding metal allergy. In addition, CAD/CAM resin blocks can be used as a substitute material for alloys by clinicians. Thus, it is advantageous to use resin blocks, considering the steep rise in the price of the gold-silver-palladium alloy.

USE OF CAD/CAM RESIN BLOCKS

The pharmaceutical industry production statistics survey conducted in 2017 presents the latest data on the use of CAD/CAM resin blocks in Japan11). As seen in Fig. 1A, the annual sales of blocks used for premolars showed a rising trend from 1,218,200 blocks and 2,498,000,000 yen in 2015 to 1,482,500 blocks and 2,640,000,000 yen.
in 2016 and 1,775,000 blocks and 2,965,000,000 yen in 2017; the numbers are expected to reach 1,904,500 blocks and 3,070,000,000 yen in 2018, when their application was extended to the molar regions.

Initially, there were four manufacturers that occupied the market with a yield of 400 to 600 million yen. By December 2018, the number of new market entrants (manufacturers and sellers) had increased to 14 companies; however, second and third generation products have been introduced by many manufacturers who entered the market earlier, and blocks with enhanced esthetics (layering and addition of highly translucent materials) have been introduced. Furthermore, the total share of the top three companies has decreased from 69% in 2016 to 56% in 2017 because the newer manufacturers are rapidly expanding their market share with the lineup at lower prices. Although five companies have launched resin blocks for the molar regions, it is expected to grow to 1,160,000,000 yen in 340,000 blocks in 2018.

**USE OF ADHESIVE SYSTEMS FOR CAD/CAM RESIN BLOCKS**

According to the treatment guidelines of the Japanese Society of Prosthodontics, the use of resin cements is essential for the bonding of CAD/CAM resin blocks to the abutment teeth. Resin cements are divided into multistep types that require primers as pretreatment and self-adhesive types that do not require pretreatment. In Japan, five companies focus on multistep (primer) and three on self-adhesive types of cements. The increase in the clinical use of resin cements is thought to have occurred due to the prevalence of CAD/CAM-produced zirconia and ceramic restorations and the approval of the use of CAD/CAM resin blocks by the health insurance.

The shipment trend of the multistep type resin cements in Japan (Fig. 2) was 2,950,000,000 yen in 2014, 3,450,000,000 yen in 2015, 3,500,000,000 yen in 2016, 3,589,000,000 yen in 2017, and 3,715,000,000 yen in 2018. For self-adhesive type resin cements, the shipment values were 1,835,000,000 yen in 2014, 2,120,000,000 yen in 2015, 2,225,000,000 yen in 2016, 2,390,000,000 yen in 2017, and 2,460,000,000 yen in 2018. Each shipment value represents the total value of the resin cements used in all the dental practices in the country. The values were increased by 15 to 16% from 2014 to 2015 when CAD/CAM resin blocks were approved for premolars only. Subsequently, an increase in the value by 1 to 7% a year was noted. Taken together, these findings indicated that the extension of the application of CAD/CAM resin blocks to molars did not have a strong impact on the shipment values.

The use of some resin cement products is limited to CAD/CAM resin blocks only. The initial growths in the sale of these products were remarkable; however, the momentum could not be maintained and the sales started to show a decreasing trend. Currently, manufacturers aim to provide an adhesive system that is compatible with their own CAD/CAM resin blocks; moreover, the users of these blocks prefer to match them with an adhesive...
system produced by the same manufacturer. This could be the reason for the stagnation or decrease in the sales of resin cement products sold by manufacturers who did not sell CAD/CAM resin blocks.

Several laboratory studies have investigated the bonding of resin cements to resin blocks. Many reports suggest that the bond strength varies even if the appropriate resin blocks and cements specified by the manufacturers are used. Furthermore, a clinical study reported a relatively high debonding rate (approximately 10%) for restorations produced from CAD/CAM resin blocks. Thus, clinicians appear to be facing challenges in selecting appropriate bonding systems and conducting proper clinical procedures owing to the various types of dental materials available. Moreover, another study reported that the fracture rate of CAD/CAM restorations was nearly 5%. Therefore, further studies are required to improve the physical properties of the block and the reliable bond strength thereby enabling the integration of the tooth structure to the restoration, resulting in a decrease in restoration fractures.

CONCLUSION

Due to the continuous rise in the prices of gold and palladium, coronal restorations for premolars and molars using CAD/CAM resin blocks were included in the health insurance system in Japan as an alternative for alloys. The application of this material to first molars has been approved in patients who possess all four second molars and present with a stable occlusion; hence, it is necessary to improve the reliability of resin blocks against occlusal loads. Furthermore, to reduce the instances of debonding, coronal restorations aimed at enabling the integration of the restoration to the tooth structures will continue to remain as a major issue in restorative dentistry.

ACKNOWLEDGMENTS

Supported in part by a grant from Japanese Dental Science Federation, JDSF-DSP1-2018-121-1.

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