When the marginal cement space was set zero in the designing software and the radial and occlusal cement space were set 80 μm starting 1mm above the finishing line, as the crown approaches the final position, there is no space for escapement of the cement through the marginal cervical collar. The closing angle between the tooth preparation and the restoration becomes smaller, the flow of the cement is restricted and its escapement becomes more difficult [13]. Furthermore, frictional resistance and hydraulic pressure development may lead to incomplete crown seating.

The marginal seal may be affected by the marginal fitness of the crown, as it will affect the amount of luting agent exposed to the oral environment [14]. Inadequate crown seating results in an increased thickness of the cement layer within the crown. Some authors revealed that increasing the resin cement thickness could reduce the bond strength because a thicker cement layer results in higher polymerization shrinkage that creates greater stress at the adhesive interface and leads to gaps formation [15].

Hammood and Ibraheem [11] reported that RelyX Ultimate showed lower marginal and internal gaps than RelyX U200 and Riva Luting Plus luting, which can be explained by its higher flowability and lower viscosity that resulted in better adaptation. Furthermore, microleakage and adhesive performance are strongly connected. Microleakage could lead to failure of adhesion, and weak adhesion could lead to microleakage [16].

Riva Luting Plus RMGI cement showed higher microleakage than both resin cements. This can be explained by the several differences between RMGI cements and resin cement, including their lower bond to tooth structure [7], lower bond to zirconia [8], shrinkage/expansion [6] and thermal coefficient [5].

The coefficient of thermal expansion of the RMGI materials (-85*10–6C–1) and the resin materials (64.5*10–6C–1) are both greater than the coefficient of thermal expansion of the tooth (11*10–6C–1) [17]. Thus, at high temperatures, the tooth and the resin materials expand while the RMGI materials contract. This leads to higher stresses to the bond of RMGI cements than resin cements during thermocycling and water storage [14]. Furthermore, RMGIC demonstrates a loss of adhesion to the zirconia during thermocycling and water storage [18].

The results of this study are in agreement with [3, 14, 19]. On the contrary, a study reported more bacterial microleakage in crowns luted with resin cement than crowns luted with RMGI cement [20]. This could be explained by the antimicrobial action of fluoride ion released from RMGIC that may had reduced the bacterial microleakage or may be due to the use of different testing methods.

When comparing the two types of resin cements, self-adhesive resin cement (RelyX U200) showed higher microleakage than the adhesive resin cement (RelyX Ultimate), which showed the lowest microleakage among all cements.

This may be explained by the fact that multistep etch and rinse adhesive resin cements present higher immediate and long-term bond strength than simplified all-in-one self-adhesive cements [21], as adhesive resin cement have the ability of formation of a hybrid layer with an excellent quality which ensures adhesion and resistance to various stresses. Furthermore, a dentine bonding agent also has the capacity of sealing the cut dentinal tubules. Although conventional resin cements are more technique sensitive, they are more capable of interpenetrating the demineralized dentine [21].

This could be partly explained by the strong etching and resin infiltration of the etch-and-rinse adhesive resin cement with subsequent hybrid layer formation, which can result in stronger micromechanical bonding to the tooth structure and low microleakage scores. Furthermore, bonding agent's application to the dentine before applying the cement enables the formation of dentine bond before the polymerization shrinkage of the luting cement occurs. This may decrease the chance of the formation of gaps [22].

On the other hand, the weaker adhesion of the self-adhesive resin may be due to several reasons; the self-adhesive cements are unable of true hybrid layer formation, a shallow, irregular and deficient hybrid layer was formed [23]. Furthermore, no distinct dentine demineralization or hybridization had been observed by Rely X Unicem. The bonding mechanism is similar to glass ionomers with an intermediate interfacial layer incorporating partially dissolved smear layers [24]. This can be explained by its reduced dentinal infiltration due to its low demineralization ability; the formation of the inadequate hybrid layer is influenced by the increase in its viscosity, despite its high initial PH [25].

Furthermore, the chemical composition of the cement plays an important role, where adhesive resin cement is more hydrolytically stable as opposed to the self-adhesive resin cement that incorporates acidic monomers in its chemical formulation to be capable of etching the tooth structure [26]. These acidic monomers are hydrophilic and result in increased water sorption, which in turn mediate hydrolytic reactions at the adhesive interface, thereby compromising adhesion to tooth structure [27].

Simplified self-adhesive resin cement is characterized by a low degree of conversion as opposed to etch-and-rinse adhesive-based resin cement. This leads to increased microleakage as a consequence of leaching out of the residual monomer and ingress of the oral fluids through the created micro gaps [28]. This may be caused by the acidic monomer, which consumes tertiary amines in some cements, resulting in incomplete polymerization, leading to a reduction in bond strength.

An additional issue regarding the simplified self-adhesive resin cement is its pH neutralization behaviour. Upon mixing and manipulation, these cements have low PH,

which is an essential feature for the adhesion to the tooth structure. Cement with inadequate Ph neutralization after self-curing can reduce the mechanical properties, thus affecting the long-term adhesion [25].

Results of the present study are in agreement with [1, 16, 29]. Contrary to this, [30] reported that self-adhesive cement showed the lowest microleakage scores. However, this can be explained by the use of different crown and luting materials and different test conditions.

CONCLUSIONS

Increasing the marginal cement space thickness to 25 µm reduced the amount of microleakage of zirconia crown restorations. Furthermore, RelyX Ultimate adhesive resin cement showed the lowest amount of microleakage compared to other types of luting cements.

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