"Influence of different cavity designs and restorative protocols on fracture resistance and induced strain of weakened thermo-cycled maxillary premolar teeth: An in-Vitro study"

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To my beloved family& my fiancé

Thank you for your endless love,

support & sharing my hard times.

You sincerely light my path and bless

every step.

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Restoration of MOD cavities in premolar teeth is always considered as a challengeable procedure, since loss of marginal ridges in premolar teeth weakened the remaining tooth structure and drastically diminishes its fracture resistance to occlusal stresses. Evolution of esthetic dentistry through technological advances in restorative materials, adhesive systems and conservative preparation designs has drawn great attention to the concept of minimally invasive dentistry associated with the usage of adhesive restorations for the reinforcing the weakened remaining tooth structure in many clinical cases such as weakened maxillary premolars . (1, 2)

The adhesive techniques are widely used in the restoration of weakened teeth to increase the stiffness of the restored tooth unit, and protect the restored tooth against fracture in clinical service. Many studies have been reported that the adhesive restorative materials have the ability not only to replace the lost tooth structure but also to reinforce the remaining unsupported tooth structure acting as “internal splint” to the remaining tooth structure. Thus increase the fracture resistance and promote effective marginal sealing. This has been considered to be of particular importance in the restoration of weakened posterior teeth. (3, 4) Hence, the choice of restorative material regarding its mechanical characterization is very important to understand the biomechanical behavior during oral function.

It is well documented that the most clinically relevant problem of resin-based composite material is the polymerization shrinkage with its associated stresses. Multiple attempts have been done to overcome this most important problem. (5) Most of these attempts are directed towards reducing the released shrinkage stresses such as incremental layering technique and more recent the production of the novel classes of bulk-fill resin based composites (RBCs) materials. Manufacturers have marketed bulk- fill RBCs that can be placed in a single 4-mm increment and still have adequate light polymerization, low polymerization shrinkage and reduced cuspal deflection ,compared to conventional composites, hence improved its physical and mechanical properties to endure the higher masticatory stresses. [6,7,8]

Since many studies have been clearly reported that the fracture resistance of weakened maxillary premolars is highly dependent on the amount of remaining tooth structure preserved during operative procedures, therefore the primary aim in restoring weakened maxillary premolars is the preservation of the maximum amount of remaining tooth structure and maintaining both function and esthetics. This may increase the fracture resistance of the premolar teeth and hence its durability.

The creation of elongated cusps due to MOD cavities in premolar teeth increased the risk of cuspal flexion under load and tooth fracture. Thus recently, several clinical trials have recommended that occlusal cuspal coverage for the restoration of weakened premolar teeth with MOD cavities could obtain promising results in terms of the fracture resistance and tooth stiffness of such restored teeth. [9,10,11]

The more closely a test simulates the clinical condition, the more likely the results are clinically relevant. Intraoral occlusal forces create dynamic repetitive loading. Therefore, it is more clinically relevant to test the specimens under occlusal loading. Adding moisture and controlled temperature to the environment is found to be important when measuring the fracture resistance of direct resin-based composites. [12]

Literature has well addressed that proper cavity preparation design, the restorative material used, and the interactions between material, restored teeth, and the oral environment may have a great influence on the clinical survival of restoring a weakened premolar teeth. [13, 14] Compromises should then done between the material resistance and the most suitable cavity design in terms of biomechanical behavior of this complex. Moreover, nowadays it has been recommended to move away from the blind application of "minimally invasive dentistry" to a more realistic concept of "minimally hazardous dentistry", which is particularly pertinent to large and deep cavities.(15) In order to accomplish this goal, the critical factors which might provide optimal biomechanical characteristics of tooth-restoration complex should be defined.

Unfortunately, unresolved controversy exits concerning definitive restorative protocol and performance of restorative materials for treatment of weakened maxillary premolars with variable remaining tooth structure to improve their fracture resistance under occlusal load. Therefore, the evaluation of influence of different cavity designs and restorative protocols on fracture resistance and induced strain of MOD cavities in maxillary premolar teeth after subjecting to thermo-cycling loading might be of value.

The main goal of restorative dentistry is to restore teeth in their form, function and aesthetic so as to achieve favorable stomatognathic environment. For many years amalgam is one of the most popular restorative materials. It is a well-documented fact that by restoring a tooth with amalgam one cannot increase the fracture resistance of prepared tooth. The shortcomings of amalgam restorations mainly aesthetics have motivated the clinicians to search for better material formulations which mask the undesirable effects and fulfill the need of better aesthetic posterior restoration (16). In the last few decades, the demand for adhesive aesthetic restorations in restoring and reinforcing the weakened remaining tooth structure of posterior teeth has increased.

Nowadays, Resin composites have considered worldwide to be the first choice adhesive material for direct posterior restoration due to improvements in their mechanical properties. Heintze et al., 2017, (17) conducted a systematic review focusing on the quantity of restorative materials sold. They reported that in 2015 alone, around 800 million, resin composite restorations were placed worldwide, with about 20% in anterior teeth and 80% in posterior teeth. These 800 million resin composite restorations represent one of the most predominant medical interventions in the human body. Alvanforoush et al. ,2017, (18) reported that the resin composite restorations in posterior teeth have similar overall clinical failure rates between 1995–2005 and 2006–2016 about 10.59% and 13.13% respectively. These researchers also reported that higher fracture rates of resin composite have been noticed with the increase in the size and surfaces of composite restorations in posterior teeth, Hence, resistance to fracture of the resin composite material is an important mechanical property, especially for extensive restorations. Based on these failure rates, Tsujimoto et al. ,2018, reported that, it can be realized that from the resin composite restorations placed in 2015 , at least 32 million will be replaced or repaired by 2025 due to fracture This suggests the concupiscence of continuous