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TWO BODY WEAR OF COMMONLY USED DENTAL CERAMICS AND ENAMEL"

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ABSTRACT

Statement of Problem- Wear behaviour of a restorative materials is an important mechanical property to be considered during selection. Dental ceramics have been the mainstay of esthetic dentistry for more than 100 years. However, dentists remain suspicious about its potential abrasivity. Newer ceramics are being considered to be more wear friendly.

Methodology- The present study evaluated and compared the wear resistance of one conventional dental ceramic, one low fusing ceramic and one heat pressed ceramic against human enamel. Human enamel specimens were taken as control. Wear simulation was performed in a pin on disc wear system with 18 N load, 120 rpm speed for 20000 cycles. Wear rate and loss of height was calculated for all specimens and subjected to one was ANOVA followed by post hoc Tukey b analysis.

Results- Ceramics exhibited lower wear rate than human enamel specimens ($p<0.05$). Among ceramics heat pressed ceramics showed least wear. For antagonist wear conventional ceramics and low fusing ceramics caused similar ($p>0.05$) wear of enamel antagonists which was higher than heat pressed ceramics ($p<0.05$).

Conclusion- Newer ceramic formulations are more wear resistant than conventional ceramics and cause less wear of opposing teeth.

KEYWORDS : wear, wear simulator, ceramic, enamel, lower fusing ceramic, heat pressed ceramic, wear rate.

INTRODUCTION

The introduction of new technologies in combination with access to new restorative materials has greatly influenced treatment concepts in Dentistry. With these developments, important changes of treatment concepts have occurred with a focus on prosthetic dentistry. These options allow strategies and materials to be selected specifically for the individual patient's needs.[1]

In recent years, ceramics have become the most commonly used restorative materials. Adhesive dental ceramics have proven to guarantee optimal esthetic results alongside satisfactory mechanical properties. Due to these qualities, today they are considered the first-choice restorative materials both for minimal restorations and for the reconstruction of severely compromised teeth.[2,3]

Restorative materials play an important part in wear, and differ significantly with respects to wear. Materials may be worn by enamel or they may cause aggressive wear of enamel. Wear of restorations may involve systemic consequences via the ingestion or inhalation of worn material and, on the other hand, it may have biological consequences on the stomatognathic system via alterations of tissues and cells due to mechanical loading and change of vertical height between the lower and upper jaw.[2,4]

The proper selection of restorative materials is important to preserve function and occlusal harmony. Excessive wear results in unacceptable damage to the occluding surfaces and alteration of the functional path of masticatory movement.

Dental ceramics have been the mainstay of esthetic dentistry for more than 100 years.[4,5,6.] However, dentists remain suspicious about its potential abrasivity. The severity of this problem is stated by Wiley as "Group function in porcelain can elicit group destruction". This shortcoming has made dental ceramics a subject of criticism. Dental research in ceramics have addressed response regarding wear problem. This concern has directly influenced the development of newly introduced ceramic materials and laboratory processing systems.[8]

Due to the high number of products available and the speed at which new products are being introduced, today's clinician faces a complex decision process when choosing a restorative material for a particular indication. The selection is seldom made on the basis of a thorough understanding of the materials' characteristics. Wear behaviour of a restorative material is an important mechanical property to be considered during selection. Therefore the present study conducted to evaluate and compare the wear resistance of indirect resin composites and dental ceramics against human enamel.

MATERIAL & METHOD-

The study was conducted with four study groups which were Group I-conventional Feldspathic glass ceramic fabricated by sintering (Ceramco 3, Dentsply Sirona); Moderately filled glass ceramic fabricated by sintering (Finesse low fusing, Dentsply Sirona); Group III- Highly filled glass ceramic fabricated by heat pressing Leucite reinforced (Cergo, Degudent, Gmbh) and Group IV Control (human enamel).

Ten cylindrical specimens of 15mm diameter and 2mm of thickness were prepared from each test material. Group I and II specimens were prepared from Feldspathic glass ceramic (low fusing) and moderately filled glass ceramic (ultralow fusing) used for veneering metal/ ceramic copings. Twenty metal disks of 15 mm diameter and 1mm thickness were prepared from ceramic alloy by conventional procedure of wax pattern fabrication, sprueing, investing and casting as per manufacturer's recommendations for group I and II (n=10). After devesting, sprues were detached and metal disks were finished. These disks were sandblasted to remove oxide layer and cleaned in ultrasonic cleaner. Metal disks were subjected to oxidation firing as per manufacturer's recommendations. Subsequently opaque and dentine layers of respective ceramic material were applied and fired according to firing chart as recommended by manufacturer.

Group III specimens were fabricated from Leucite reinforced ceramic by heat pressing method. Ten wax patterns of 15 mm diameter and 2mm thickness were prepared from ceramic wax. Wax patterns were invested in ceramic investment and burn out was performed. Ceramic ingots with plungers are mounted on burnt out casting rings and placed in heat pressing unit. Heat pressing was performed as per manufacturer's instruction.

Ten control enamel samples were prepared by slicing buccal surface of non carious freshly extracted adult human molars. These enamel specimen were mounted in direct composite and shaped according to the measurement of the test specimens.

Antagonist tooth specimen were prepared by sectioning extracted premolars mesiodistally and isolating the buccal cusps. After initial measurement the specimens were subjected to wear simulation in a pin on disc wear system. The specimens were mounted in the sample holder of the wear simulator with the help of auto polymerizing resin block. The horizontal or wearing arm consisted of antagonist tooth sample (buccal cusp of maxillary premolar). It was adjusted over the sample surface to produce a rotational sliding type of wear. the holding screw was adjusted and a load of 1.8 kg was applied over the arm and the rotation of the wear simulator was reduced to 120 rpm using a dimmerstat. After these adjustments the wear simulation procedure was performed for 20000 cycles for each specimen.

Initial and final measurement of specimens and antagonists with respect to weight of the specimens and height of antagonist (tooth) before and after wear simulation were measured and recorded.The loss of weight of specimens after wear simulation was calculated. The wear rate of specimen was calculated by finding the ratio of this weight difference (mg) and the distance travelled (m) by the sample pin against the disc. Distance travelled by antagonist is calculated by multiplying circumference of wear track to number of wear cycles. Loss of height of antagonist was calculated by finding difference between initial and final height of antagonist.

RESULTS-

Table 1 shows mean, standard deviation and statistical analysis for wear rate and antagonist wear of all groups. Significant differences were observed in the wear behaviour among the ceramic materials investigated. Ceramics exhibited less wear rate than control (human enamel). Among the ceramics heat pressed highly filled leucite glass ceramic exhibited least wear rate followed by moderately filled low fusing glass ceramics and feldspathic glass ceramics respectively. Feldspathic glass ceramics caused more wear of antagonist as compared to moderately filled low fusing glass ceramics and heat pressed highly filled leucite glass ceramic.

Table 1- Wear rate and antagonist wear of all test materials

GROUP	WEAR RATE (Mg/cm) Mean±S.D.	ANTAGONIST WEAR (mm) Mean±S.D.
Conventional ceramics (Group I)	0.00098±.000063246[a]	0.185±.00527[a]
Low fusing Ceramics (Group II)	0.00077±.000030185[b]	0.180±.00667[a]
Heat Pressed Ceramic (Group III)	0.00034±.000032318[c]	0.174±.00516[b]
Control (Group IV)	0.00139±.000030551[d]	0.137±.00483[c]

*same superscript letters indicate no statistically significant difference

DISCUSSION

Wear may be defined as the loss of matter which is manifested by the loss of anatomical form. The process occurs commonly the oral cavity and is dependent on various factors which affect and act together in a combined way. These factors include the abrasiveness of food particles, enamel characteristics including thickness and hardness (which depend on degree of mineralization), and pH and nature of the saliva, neuromuscular force etc. Parafunctional habits further aggravate this process.[1,9]

Excessive wear of antagonistic teeth may lead to multiple complications like destruction of periodontal tissue, hypersensitivity, fatigue of masticatory muscles, loss of occlusal contact, loss of masticatory efficiency, faulty tooth relationship, and changes in the vertical and horizontal jaw relations, which may cause functional and esthetic impairments.[2,17,19] Restorative materials are also subjected to wear in the oral cavity as similar to enamel and dentin. The wear mode of restorative materials depends on the type and composition of restorative material. Material loss may occur through microploughing, microcutting, microcracking, and microfatigue.[10]

One of the physical properties that are important for a restorative material is the ability to withstand wear. Wear resistance is an important requirement to be considered for a dental material to be accepted by both dentists and patients. Different restorative materials themselves may cause wear of opposing surface or may wear themselves due to action of opposing surface. Ceramics are commonly preferred as the restorative materials of choice in dentistry due to their esthetic properties.[5,6,7]

Based on their composition dental ceramics can be classified into three categories: glass based, glass-infiltrated, and non-glass-based (polycrystalline) ceramics. Glass-based ceramics may further be divided according to the percentage of added particles, into three subclasses: predominantly glass, moderately-filled, and highly filled glass.[11-13] Further ceramics can be fabricated by sintering process, heat pressing, CAD CAM, copy milling and slip casting. Ceramics can be used as metal ceramic or all ceramic prosthesis. Metal ceramic prosthesis has a metal coping which is veneered by sintered ceramics. All ceramic prosthesis has a ceramic coping which may or may not be veneered with sintered ceramics to give final translucence and esthetics.[3,6]

Ceramic is the material which is routinely used in Fixed Prosthodontics for the fabrication of crown and bridges. Due to their excellent esthetics and color stability, ceramics are the most preferred esthetic materials used in dentistry. They are known for their natural appearance, biocompatibility, long term color stability, refractory nature, inertness, insulating properties, ability to be formed in precise shapes etc.[5,6,14]

Inspite of all its advantages, ceramics are associated with one major disadvantage of causing serious clinical loss of enamel opposing conventional dental ceramics. This has been a matter of serious concern causing biologic failure of ceramics.

Among the ceramics investigated heat pressed highly filled leucite glass ceramic exhibited least wear rate followed by moderately filled low fusing glass ceramics and feldspathic glass ceramics respectively. These findings are similar to that of Jongee Park et al[14] who investigated wear behaviour of heat pressed and veneering dental ceramics. They attributed this difference in wear behaviour to chemical composition and microstructural characteristics of ceramics.[14,15,16] On contrary to this, in a study conducted by Arcangelo et al[9], they found that CAD CAM feldspathic exhibited promising wear behaviour when compared to other ceramics, gold and enamel. This difference can be explained on basis of different fabrication process in both studies.

Ceramics have glass phase and fillers. The main component in glass ceramics is glass phase which is responsible for brittle break mode under stress.[17] The glass phase is highest in feldspathic glass ceramics (low filler), followed by low fusing glass ceramics (moderately filled) and heat pressed leucite glass ceramic (highly filled) respectively. Thus justifying wear behaviour of these materials. Further lower fusing ceramics are claimed to be wear friendly because of their lower hardness, lower concentration of crystal phase and smaller crystal sizes.[8,15,16] Ultra low fusing glass ceramics and heat pressed leucite glass ceramic have lower fusing temperatures as compared to feldspathic ceramics.

Feldspathic glass ceramics caused more wear of antagonist as compared to moderately filled low fusing glass ceramics and heat pressed highly filled leucite glass ceramic. Presence of higher amount of glass phase in feldspathic ceramics can be cited as the reason for increased enamel wear.

CONCLUSION-

Currently used dental ceramics are developed to be more wear friendly to enamel surfaces. Ceramics are the most preferred choice for esthetic restorations in oral cavity and are gold standard for esthetic materials with their suitable esthetic and mechanical properties. Further there is no single ideal material which can be used for all restorative systems, it is up to the operator to choose the appropriate restorative material and technique according to the clinical situation.

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