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Correlation between the molecular composition of the polymers and their use in prosthetic dentistry

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ABSTRACT: Introduction: With the advent of the porcelain, the use of the polymers diminished despite their improved features and expanded clinical applicability. Purpose: The purpose derives from the fact that there are absolute indications for the use of polymers as veneering materials for the dental bridges in the everyday dental practice. Methods As the material we used 200 patients divided into two groups. First group was professional boxers with dental bridges veneered with chained-linear polymers and second group was patients with bruxism with dental bridges veneered with cross-linked polymers. The measurements of color stability, strength and endurance to masticatory pressure were in 3 intervals: beginning, after 18 and 36 months. Results: In the first group, there were 0 polymer discolorations on the first measurement and 15(15%), 20(20%) on the second and third measurement respectively compared to the second group with 0 discolorations on the first and second and 30(30%) on the third measurement. The polymer strength estimated with the number of fracture spots for the first group was 0 for on first and second and 10(10%) on the third measurement and for the second group was 0 for each measurement. Masticatory pressure endurance for the first group was *f*(x)=200,75N, *f*(x)=271,00N, *f*(x)=290,55N on the first second and third measurement respectively and for the second group was *f*(x)=190,55N, *f*(x)=261,00N and *f*(x)=280,55N on the first, second and third measurement respectively. Conclusion: The linear and cross linked polymers satisfy the requirements to be used as veneering dental materials with optimal values for color stability, strength and masticatory pressure endurance.

KEYWORDS: Chain-linear polymers, cross-linked polymers, molecular composition, prosthetic dentistry, electrognathodynamometer.

1 INTRODUCTION

Despite the fact that there has been a significant progress in the development of the porcelain masses, the importance of the polymers for veneering of the dental bridges should not be underestimated. There are absolute indications for which the polymers have advantage over the porcelain as a veneering material for the dental bridges. Such cases in which these indications for veneering of dental bridges are absolute are: patients with bruxism, patients patients with deep overbite or patients that are professional boxers.

The chemical composition of the polymers is adequate for their use as dental materials for veneering of dental bridges because their atoms are connected with cohesion forces. The connection between the atoms can be primary or secondary. The strength of those connections and their ability to create links determine the chemical and physical properties of polymers.[1] The polymers according to the spatial arrangement of their molecules are classified into the following types:

1. **Linear or chain polymers**- Easily manipulated, stretched, bent, thermoplastic, hard. These polymers are used for fabrication of vestibular veneers.[2]

2. **Branched polymers** are easily manipulated, stretched, bent, thermoplastic, and harder.

3. **Cross-linked polymers** are strong, stiff, thermoset, wear resistant and this is why they are used for fabrication of occlusal surfaces of actylic teeth

4. **Coiled chains** are flexible and are used as impression materials.

5. **Crystalline polymers** have very regular arrangement in space. They are strong, stiff, and absorb less water.

6. **Amorphous or glassy polymers** have irregular arrangement of the monomers and behave as a brittle solid substance.

In order for the polymers to be used as a veneering material for dental bridges they need to have particular characteristics such as: resistance to masticatory forces, stress resistance, strain ability, strength, hardness, friction and wear resistance in relation to the masticatory force

The endurance of the masticatory force exhibited by the polymers, essential for their use as a veneering material, is achieved only when the external masticatory force that affects the polymers is opposite in direction, but equal in magnitude with their internal cohesion force.[3]

Because the fabrication of dental bridges is part of the esthetic restorative dentistry, the polymers are required to fulfill particular optic properties. Optical properties of the polymers are particularly important because these materials have to meet high aesthetic criteria. The process of selecting the tint, hue and shade of the polymer is an art form intended to determine the color and appearance of the dental polymers and its' resemblance to the remaining natural teeth. The perception of color is the result of a physiological response to physical stimuli and represents a subjective experience.[4]

2 PURPOSE

The purpose comes from the fact that there are absolute indications for the use of polymers as veneering materials for the dental bridges in the everyday dental practice

3 METHODS

As a material for our research, we have used 200 patients with dental bridges veneered with polymers.

The first group of 100 patients had an absolute indication for fabrication of dental bridges from polymer materials because they practiced contact sports (professional boxes, basketball players, handball players, football players, volleyball players) in which as polymer materials were used SR Adoro from Ivoclar Vivadent that by their chemical composition are chain or linear polymers. The polymers in the first group of patients were used for fabricating the vestibular veneers on the partially veneered metal substructures from the dental bridges.

The second group included the remaining 100 patients that were previously diagnosed with bruxism and thus had an indication for fabrication of dental bridges from polymer materials. The used materials in these patients were GC Gradia that by their chemical composition are cross-linked polymers. The above mentioned materials were used for complete veneering of the occlusal and vestibular surfaces on the metal substructures from the dental bridges

Examinees were analyzed for duration of 3 years in three intervals: immediately after the delivery of the dental bridges to the patients, after 18 months and after 36 months.

The color stability was being investigated. The color stability of the dental material is a term that speaks of the time period in which there are no changes in the optical properties and the characteristics of the polymer. The color of the polymers represents a determining aesthetic factor. Each polymer is artificially added a various set of colors during the fabrication process. For determination of the color from the polymer used in the dental bridge, we used a shade selector i.e. IPS e.max shade selection wheel from Ivoclar VIvadent. The stability of the color was determined by means of visual inspection, during which changes in the consistency of color were recorded in an individual chart. The individual chart for each of the clinical cases was used for following of the situation of the patients who participated in the investigation. The initial hue of the chosen polymer for fabrication of the dental bridge was noted in the initial stage of the experiment. At later measuring time intervals the initially recorded hue was compared to the color of the dental bridge in situ. Each color transformation was noted in the special chart by the corresponding code according to the IPS e.max shade selection wheel from Ivoclar Vivadent. The value of the color stability was estimated by the number of total color transformations during the entire time period of the investigation (Fig. 1).

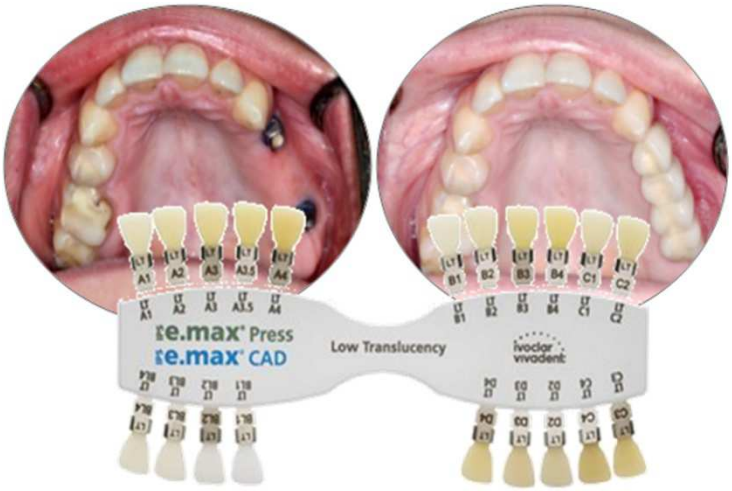

Figure 1. Measuring the color stability of the polymers

The strength of the polymer was analyzed by determining the total number of incurred fracture spots. Strength is a measurement that refers to the energy required to deform a material or energy needed to cause a fracture. Strength can be defined as a measure of fracture resistance. The strength of the material from which the dental bridges were fabricated was valued according to the number and surface of the aquired fracture spots during the entire period of intraoral appliacation (Fig. 2).

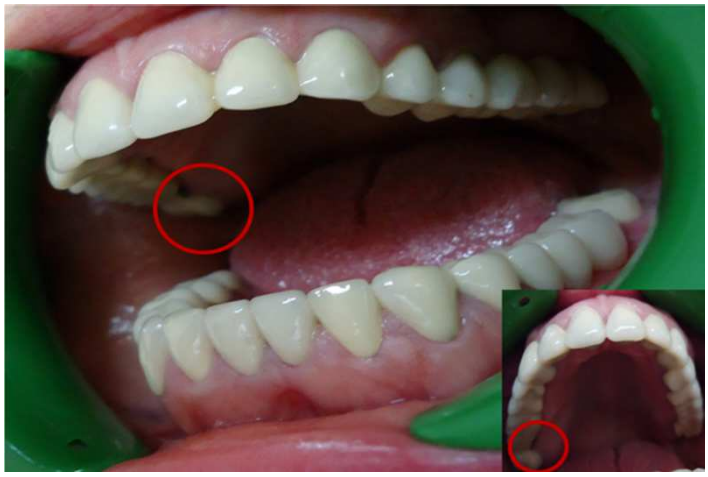

Figure 2. Measuring the acquired fracture spots of the polymers

The measurement of the endurance to masticatory pressure by the dental polymer was done using electrognatodinamometar (individually designed by the author) a.k.a. electronic gauge 500 N, CAL. FAKTOR. SPAN 1000 specially designed for measurements in dentistry individully constructed by Kapusevska (Fig. 3).

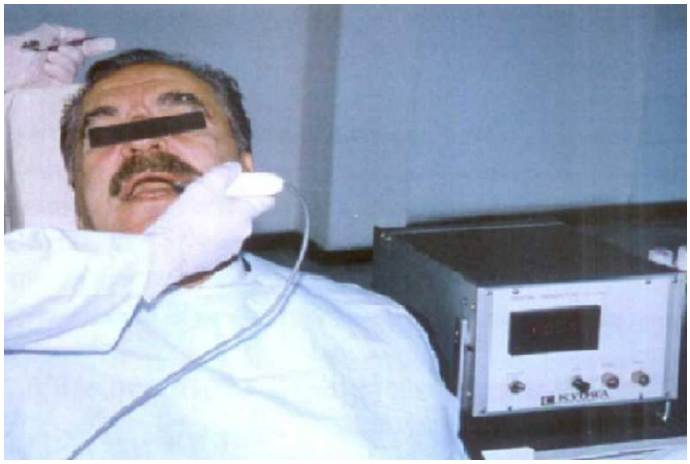

Figure 3. Measuring the strength of the pressure using electrognatodinamometar on dental prosthesis with polymers

The value of endurance to masticatory pressure was expressed in Newtons: 1 CR = 9,80665 N = 10 N.

4 RESULTS

Statistical processing of data obtained from the given parameters for investigation of the polymers of the dental bridge is performed using the statistical package for PC Statistica for Windows, RELEASE 4,5-A, COPYRIGHT-StatSoft , Inc, 1993.

Electrognathodynamometric measurements for the mastication pressure were statistically processed with the function of average value *f*(x).

The obtained data from the investigation of the first 100 examenees, for whose dental bridges were used linear or chain polymers is placed in Table. 1.

Table 1. First group of examinees with dental bridge of chained or linear polymers

	First group of patients		
	Beginning	18 months	36 months
Color stability	100 (100%)	85 (85%)	80 (80%)
Strength	100 (100%)	100 (100%)	90 (90%)
Mastication pressure	*f*(x)=200,75 N	*f*(x)=271,00N	*f*(x)=290, 55N

In the first group of patients, on the initial measuring period there was no change in color in any patient. In the second measuring period only 15 (15%) of patients had a change of color with polymer tarnishing, and in 85 (85%) there was no change of color. After 36 months, in 80 (80%) examinees there was no discoloration in the polymers, in 10 (10%) there was complet darkening in the hue of the polymer as a result of daily use of tea and coffee by the patients themselves. In 10 (10%) of patients there was only stained gingival edge of the dental bridge that was a product of reduced oral hygiene. When analyzing the strength of the polymer in the same group of patients in the first and second period of analysis there were no fracture spots. After 36 months in 90 (90%) of examinees there was no fracture of the vestibular veneers, and in 10 (10%) patients minimal fracture spots were detected. The endurance of the masticatory pressure in the second group of patients, on the first measuring period (the shortest period for adaptation of the patient to the dental bridge), the lowest value for the mastication pressure was received *f*(x) = 200,75 N, after 18 months *f*(x) = 271,00N and after 36 months *f*(x) = 290, 55N.

In the second group of 100 examinees the results are shown in Table. 2.

Table 2. Second group of patients with dental bridge of cross linked polymers

	Second group of patients		
	Beginning	18 months	36 months
Color stability	100 (100%)	70 (70%)	70 (70%)
Strength	100 (100%)	100 (100%)	100 (100%)
Mastication pressure	*f*(x)=190,55 N	*f*(x)=261,00N	*f*(x)=280,55N

At the time of the first measurement there was no discoloration of the polymers. After 18 months there was tarnishing in the color of the polymer in 20 (20%) of patients, in 10 (10%) there was staining of the gingival margin, and in 70 (70%) there weren't any changes. After 36 months we found the same results. The examination of the strength of the cross-linked polymer showed the result that in the three measuring time periods there was a lack of fracture spots on the polymer of the dental bridge. At the time of the measurement of the endurance of masticatory pressure from the cross linked polymers, the following results were obtained: in the first period of measurement *f*(x) = 190,55, N, after 18 months *f*(x) = 261,00N and after 36 months *f*(x) = 280,55N.

5 DISCUSSION

From the use of polymers with different molecular arrangement a comprehension was obtained that linear or chaned polymers which are mostly used for the fabrication of vestibular veneers of the dental bridges or for their repairment satisfy the necessary requirements. The alteration of the color of these polymers in the first group of patients resulted from reduced oral hygiene of the dental bridges. From the examinations in the first group of patients based on established questionnaires followed the realization that the aquired fracture spots on the polymers were a result of negligence by the patients themselves (use of toothpicks).

The use of cross linked polymers led to the conclusion that they are polymers of choice for the fabrication of occlusal surfaces of the dental bridges. The change in color of the polymer is the result of the same cause as in the first group of polymers. The tarnished gingival edge of the polymer toward the gingiva is caused by the patients themselves or the patients' habits of maintaining the oral health. The most specific feature found from the examination of these polymers, which is important for their use for vennering of the dental bridges is that we didn't find any fracture spots in the three time periods of examination.

Chewing creates forces that are transmitted to the teeth and dental restorations. The size of the forces varies from the position of the teeth and it's individually different (3).

Maximum masticatory preassures reach and exceed the value of 1200 N (4,5), while the average value for mastication pressure in the urban population is 500 N on the lateral teeth.[5, 6] The values of masticatory pressure are important in order to establish the indications for the use of the different types of dental materials from which the dental bridges are be fabricated.

The measurements of the endurance of masticatory pressure in all the examined groups is in accordance to the literary data for the masticatory pressure in the natural teeth structures [7,8] This points in a direction that the polymers represent dental materials, which are entirely able to replace the dental tissue in each case in which the patients requires a dental bridge.[9,10, 11]

Appropriate measurements for the value of the masticatory pressure of the dental bridge were preformed on the teeth with reduced periodontal health that brought to the comprehension that these teeth shouldn't be excluded from use.[12, 13, 14] In these investigations, we have come to the realization that the teeth from the first and second stadium of the periodontal disease can be used for fabrication of dental bridges[15,16, 17, 18].

6 METHODS

After the use of the polymers on the patients with absolute indications for fabrication of dental bridges veneered with polymer we arrived at the following conclusions:

1. The polymers as veneering material for dental bridges are featured with color stability in a wide time period of use by the patient;
2. The strength as a feature of the polymers is satisfactory when the appropriate polymer is used as a veneering material with its specific molecular arrangement;

- Polymers that by their molecular arrangement are linear should be used as a veneering material in patients that practice contact sports;
- Polymers that by their molecular arrangement are cross linked should be used as a veneering material in patients with bruxism;

The masticatory pressure of the polymers approaches the values of the natural teeth structures;

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