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ORIGINAL RESEARCH

Effect of Base Metal Alloys Recasting on Marginal Integrity of Castable Crowns

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ABSTRACT

Introduction: Base metals have a wide use in casting methods. Sometimes they are reused in laboratories which may have an adverse effect on the restoration marginal integrity. This study aimed to investigate the effect of recasting of alloys on marginal integrity of restorations.

Materials and methods: Models with two types of finishing lines shoulder bevel 45° and shoulder 135° were produced and 15 wax copings were formed on each one of them. Each group containing 15 copings was divided into three subgroups A, B and C. Group A was casted with 100% new alloy, group B with 50% new and 50% recasted alloy and group C with 100% recasted alloy. Obtained metal copings were placed on dies and marginal gap size between restoration margin and the dies finishing line was measured using metric microscope and Moticam camera in four points, buccal, lingual, mesial and distal.

Results: A significant difference in mean marginal gap size exists among three types of alloys used (p-value = 0.036). A significant difference is observed between mean marginal gap size of two types of finishing lines for different alloys (p-value = 0.001).

Conclusion: Using 100% recasted alloy is not recommended for any of the two types of finishing lines.

Keywords: Marginal fitness, Dental casting method, Base metal alloy.

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INTRODUCTION

Regarding wide use of cast restorations, improving their features to have longer service is one of primary goals in restorative dentistry. One way to this goal is marginal fitness. A restoration remains in biological oral environment, only if its crown margin has adequate fitness with restoration margin.[1] Marginal fitness influences periodontal status, in the way that a misfit leads to caries under crown, followed by periodontal problems and tooth loss at the final stage.[2] Seeking for improvement of casting procedures, variable methods are being applied.[3] High noble alloys were used for dental prostheses for years; however, they were replaced because of their high costs.[4] During last decades, a lot of experiments were done on base metals, making it clear that some features of them are better than high nobles,[5] although casting is more difficult for them.[6] In almost all dental laboratories, they mix precasted base metal alloys with new alloys and use them again. Various studies on noble alloys have cleared their physical and mechanical features, releasing instructions for recasting them.[7,8] Gold alloys manufacturers state that it is possible to remelt these alloys to make an adequate restoration; however, it is necessary to use at least 50% of the new alloy. Nevertheless, secondary elements in the alloy might vaporize or oxidize, affecting final properties of the alloy, one being zinc which prevents oxidizing of other elements by its oxidization.[9] The biggest concern is about recasting of ceramic base metals, which lack trace base metals, such as iron, indium, tin and zinc, all of which influence porcelain bond, alloy hardness and the castability of alloy.[10] Due to the oxidization, vaporization and porosity in a recasted alloy, it cannot be the same as the primary casted alloy; marginal fitness for example will be different between primary casted and recasted alloy.[10] On the other hand, studies demonstrate that 100% recasted base metal alloy show higher marginal gap compared to primary casted alloy and it is recommended not to use recasted alloy singly.[8] Silver-palladium noble alloy and gold alloy type III also show less marginal gap as a primary casted alloy.[1,7] Since physical characteristics of primary casted and recasted alloys are not the same, it is important to investigate the effect of type of the finishing line on improving features of recasted alloys. Therefore, this study was designed to evaluate vertical marginal fitness of metal copings produced from three different base metal alloys (100% new, 50% new

+ 50% recasted and 100% recasted), using two types of finishing line (shoulder bevel 45° and shoulder 135°).

MATERIALS AND METHODS

In this experimental study, nickel-chrome metal base alloy (with no beryllium) was used (Dental Alloy, Noritake, Aichi, Japan). In order to prepare the specimens, two brass dies with finishing lines shoulder bevel 45° and shoulder 135° and a diameter of 4.1 mm in cervical and 3.7 mm in occlusal and a height of 5.6 mm which resembles a premolar in contour and dimension, using the machining method. After that, a bezel was made on the axial surface of the dies to prevent rotation of the coping. Impregnating the brass dies with a separator substance, inlay wax (Inlay casting wax, Kerr Europe, Sybron, Italy) was melted with a moderate heat and the wax model was formed on the coping with precision. To standardize all wax copings, first a wax coping was formed on a brass die and its thickness and marginal fitness was carefully set. Following casting of this coping using the conventional method, its thickness was equalized (around 0.5 mm) in all contours by means of a surveyor. Afterwards, an impression was provided using putty (Speedex, Asia Shimi-Teb, Tehran, Iran) and, for next times melted wax was poured into putty and placed on die. Fifteen copings were formed on each brass die (with shoulder bevel 45° and shoulder 135°) using this method. These 15 copings of each type were divided into three groups (A, B and C), each containing five copings. The first group (A) was casted with 100% new metal; the second group (B) was casted with 50% new metal and 50% recasted metal and the third group was casted with 100% recasted metal. Copings were sprued with 10 gauge sprue with a length of 6 mm (Sprue wax, Dandiran, Tehran, Iran). Cylinder no 3 was used for investing procedure while the cylinder surface was covered with Fireproof carton as a liner. Investing was performed using phosphate-bonded investment (Hinrivest, Ernst Hinrichs, Berlin, Germany). Ten wax patterns were installed inside each cylinder and after preparation, weighing water and gypsum powder, wax pattern was picked from the die and installed on crucible former with a similar space from the center. Installation was in the way that the wax pattern contour had a 1 mm distance from the end of the cylinder. On the inner and outer surface of the pattern and the sprue, wax lubricant and separating fluid (Kerr Europe, Sybron, Italy) was used. Thereafter, the excess material was removed followed by mixing water and gypsum powder (15 seconds under vacuum). Cylinder were filled with investment gypsum and left in humid environment for 24 hours and then placed in burnout unit (Kavo, Kavo type 6115, Electro techniques Werk GmbH, Germany) with a temperature of 850° and a duration of 30 minutes. After preparation of the cylinder and wax removing, the alloy was melt using a multihole torch with O_2 fuel preceding alloy casting by means of centrifuge. As the casting finished, cylinders were cooled out in room temperature. Then the investment gypsum was removed and excess investment material was cleaned out using sandblast. Inside, the copings was thoroughly investigated for lack of any porosity and in case of presence of porosities, tiny porosities were removed using a pear-shaped bur and copings with large porosities were excluded, replaced by new specimens. All groups underwent these procedures using the related alloy. Copings then were seated on the dies and sprues were disconnected. Thus, six groups were provided.

Four points were marked on mesial, distal, buccal and lingual of the dies resembling those of a natural tooth and vertical gap of the margin was measured at these points using a stereomicroscope. Measurement was performed three times for each point to minimize errors (12 measures for each coping). Later on, the mean measure was calculated for each coping. Data were analyzed using one-way analysis of variance (ANOVA), two-way ANOVA and t-test.

RESULTS

Table 1 shows types of alloys and different finishing lines. Mean marginal gap for each group is illustrated in Table 2.

Two-way ANOVA shows that there is a significant difference among the six groups (p-value = 0.036) and further analysis using LSD method made it clear that the difference was between groups A and C (p-value = 0.012). Difference between groups A and B and groups B and C was not significant. Minimum marginal gap was observed in group A and maximum was in group C.

Table 1: Groups of the study separated according to type of the alloy and finishing line

Groups	*Alloy*	*Finishing line*
Group A	100% new	A1 shoulder 135° A2 shoulder bevel 45°
Group B	50% new + 50% recasted	B1 shoulder 135° B2 shoulder bevel 45°
Group C	100% recasted	C1 shoulder 135° C2 shoulder bevel 45°

Table 2: Marginal gap size of the copings (µm)

Groups	*Finishing line*	*Mean ± SD*	*Number*	*Min.*	*Max.*
A	A1	156.11 ± 54.53	5	64.75	211.82
	A2	99.74 ± 21.53	5	85.08	136.48
	Total	127.93 ± 49.09	10	64.75	211.82
B	B1	273.38 ± 167.37	5	94.43	644.42
	B2	123.07 ± 53.08	5	43.17	191.57
	Total	198.22 ± 141.34	10	43.17	466.42
C	C1	369.40 ± 94.59	5	286.36	502.23
	C2	106.97 ± 75.99	5	52.13	237.26
	Total	238.18 ± 160.23	10	52.13	502.23

In order to compare mean vertical gap among two types of finishing lines t-test was used, revealing that groups A (p-value = 0.069) and B (p-value = 0.0116) show a significant difference between the two types of finishing lines; however, groups C was not like that (p-value = 0.001).

Used for comparison of groups with the same finishing lines, one-way ANOVA showed in shoulder bevel 45° no difference is seen among three groups of alloys (100% new, 50% new + 50% recasted and 100% recasted) (p-value = 0.793); however, in shoulder 135°, the difference among these groups is significant (p-value = 0.039) and LSD shows that the difference is between groups A and C (p-value = 0.013).

DISCUSSION

Nakaee[8] produced 60 metal models with sloping shoulder finishing line and two types of base metal alloys (Supercast and Veraband) and three different percentage of alloys (group A: 100% new; group B: 50% new + 50% recasted and group C: 100% recasted) and evaluated internal margin using microscope. He reported the minimum marginal gap for group A and maximum for group C which supports the findings of the present study. He suggested that using 100% new alloy whenever possible which supports the results of the present study. His investigation did not show any difference between Supercast and Veraband. Ayad[7] investigated marginal fitness and composition for gold alloy type III (a noble alloy). He found the maximum marginal fitness in group A (100% new) and the minimum in group C (100% recasted). Considering the difference between used alloys (Noritake base metal alloy in our study), Ayad's findings advocate the results of the present study.

Craig[6] recommends 50% new and 50% recasted alloy for reusing noble alloy.

Our study shows that it is reasonable to use 50% new alloy (wt%), since groups A and B did not have a significant difference in marginal gap while groups A and C showed a significant difference (in shoulder 135) which is in accordance with Craig's recommendation.[6]

Lopez et al[1] assessed the effect of recasting of silver-palladium alloy on marginal fitness of crowns with different shapes of crown. They stated that marginal fitness of new alloy was more ideal than that of recasted alloy. He further stated that no significant difference is observed when using different types of finishing lines; again in accordance with the findings of the present study. They also mentioned that when using recasted alloy crowns with straight shoulder finishing line and a 45° chamfer have better marginal fitness compared to shoulder bevel. In the present study, also recasted alloys with shoulder bevel 45° showed a more ideal marginal fitness compared to shoulder 135°. Lopez declared that oxidization, vaporization and porosity are all responsible for the difference between recasted and new alloy marginal gap. We have to point out that the type of alloy used in our study and Lopez et al was different.

CONCLUSION

Regarding the results of the present study, vertical marginal gap in restorations with 100% new alloy is significantly lower than that of 100% recasted alloy and this difference persists with changing the type of the finishing line. It is recommended not to use 100% recasted alloy for castable restorations.

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