

Influence of Recasting of Base Metal Alloys on Cytotoxicity – A Systematic Review and Meta-Analysis

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Abstract

Introduction: In comparison to the casting of fresh alloys, recasting of casting alters the composition and elemental release of alloys, which may have cytotoxic effects in the surrounding tissues. **Settings and Design:** Systematic review and meta-analysis. **Methods:** A well-structured search on the available literature as per guidelines was opted and digitally searched then results were analyzed. A total of 370 studies were found via PubMed, Scopus, Medline, and The Cochrane Library (Wiley) databases (PRISMA guidelines). In this review, we included *in vitro* studies on the effect of cytotoxicity on recasted base metal alloys. **Statistical Analysis:** MINORS tool was implicated for the quality assessment of the inclusion criteria applied for quasi-random trials. This scale had 10 items, and each one was evaluated as follows: 0 for not reporting the item, 1 for insufficient reporting, and 2 for satisfactory reporting. **Results:** This review evaluated two studies which met the inclusion criteria to comparatively analyze the cytotoxicity between freshly prepared alloy and recasted alloy using Review Manager 5.4. The mean difference was calculated along with a 95% confidence Interval, and a significance level of $P < 0.05$ was considered meaningful. Incorporation of 46 samples in the fresh alloy group and 46 in the recasted alloy group were allocated. The analysis revealed a significant difference in cytotoxicity, with the recasted alloy demonstrating a higher number of viable cells ($P < 0.001$). To assess the statistical heterogeneity in this analysis, the I^2 test was employed which indicated a high level of heterogeneity at 97%. Pre- and post-analysis was done using a fixed-effect model to interpret the treatment effects. **Conclusion:** This meta-analysis concluded that recasting of base metal alloys increased cell toxicity. Among the base metal alloy, the Co-Cr alloys were more adversely affected the cell viability in comparison to Ni-Cr alloys.

Keywords: Alloys, Cytotoxicity, Meta-analysis, MTT assay, Recasting, Systematic review.

INTRODUCTION

In rehabilitative dental practices, recasting of dental alloys is conventionally popular, where used dental restorations are melted down and reused to create new dental prosthesis.^[1] The process of recasting dental alloys has a long history, dating back to the early 20th century when gold alloys were first used in dentistry. Over the years, the process has evolved, and new alloys have been introduced, making the recasting process more efficient and cost-effective.^[1,2]

The primary advantage of recasting dental alloys is that it reduces the cost of dental restorations. By reusing the used dental alloys, dentists can save money on the cost of new dental prosthesis. In addition, the process of recasting dental alloys is more environmental friendly, as it reduces the amount of waste generated from discarded dental restorations.^[3,4]

However, there are also some disadvantages and potential problems associated with recasting dental alloys. One of the

main issues is that the quality of the dental alloy may degrade with each recasting cycle. This can result in the formation of defects and imperfections in the new dental prosthesis, which can compromise their strength and durability.^[5] In addition, the recasting process can also lead to an increased risk of contamination, as impurities can be introduced into the alloy during metal casting.^[5]

One of the potential effects of recasting dental alloys on oral tissues is the release of metal ions. When dental alloys are melted down, they can release metal ions such as nickel, chromium, and cobalt into the oral cavity.^[6] These metal ions

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Received: Mar. 13, 2024; **Accepted:** Apr. 20, 2024; **Published:** May. 12, 2024

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How to cite this article: Badani S, Yadav NS, Hazari P, Saxena V, Narwani S, Choure R. Influence of Recasting of Base Metal Alloys on Cytotoxicity – A Systematic Review and Meta-Analysis. J Res Adv Dent 2024;15(4):1-8.

Access this article online

Website:
www.jrad.co.in

DOI:
<https://doi.org/10.53064/jrad.2022.15.4.504>

can potentially cause allergic reactions or sensitivities in some individuals. In addition, prolonged exposure to high levels of metal ions can lead to toxicity, which can damage oral tissues and cause systemic health issues.^[7]

Finally, the recasting of dental alloys can also have an impact on the fit of the dental prosthetic. If the alloy is not recast properly or if the fit is not checked carefully, the dental prosthetic may not fit correctly, leading to irritation and inflammation of the surrounding oral tissues.^[8,9]

Meta-analysis are research method used in evidence-based dentistry that involves combining the results of multiple studies to analyze a particular research question. In the case of the cytotoxicity of recasted dental alloys, a meta-analysis can provide a comprehensive overview of the available literature on this topic.^[10]

The aim of a meta-analysis on the cytotoxicity of recasted dental alloys is to provide a systematic review of the available evidence and to determine the overall level of risk associated with this practice.^[11,12] This includes evaluating the methods used in previous studies, the types of alloys used, and the specific toxic effects observed on oral tissues.^[13]

By analyzing multiple studies, a meta-analysis can provide a more robust and reliable assessment of the cytotoxicity of recasted dental alloys compared to individual studies. This information can be used to inform clinical practice and guide decision-making when considering the use of recasted dental alloys in dental restorations.^[14]

In conclusion, the recasting of dental alloys can potentially have an impact on oral tissues. While the economic and environmental benefits of this process are important, the potential risk and its aftermath on health along with its hazardous effect on oral tissues are critical to evaluate verifying the potential risk. This includes proper testing and monitoring of metal ion release, careful attention to the quality of the recasting process, and regular checks to ensure the fit of the dental prosthetics.^[15]

METHODS

This systematic review and meta-analysis follows the PRISMA guidelines^[16-18] (Figure 1).

Eligibility criteria

Inclusivity of the preferred studies-

In the current systematic review, studies that met the following criteria were included.

1. Article published exclusively in English language were included in this systematic review and meta-analysis
2. *In vitro* randomized controlled trial (RCT) studies having mandatory comparison for cytotoxicity evaluation between fresh and recasted alloys (50%).

Studies excluded were

1. It was an *in vivo* studies
2. The studies published in English language

3. Animal studies
4. Studies done on exclusively single population (either fresh or recasted alloy).

Focused question

Does the recasting increases the cytotoxicity of base metal alloys?

Search strategy

Two different electronic databases as the source of literature search as per the guidelines including MEDLINE/PubMed/Webscience, the Cochrane Register of RCTs, and the Database of Abstracts of Reviews of Effects for English-language clinical studies reporting on the cytotoxicity of recasted alloys.^[19] A search for research describing precisely the effect of cytotoxicity of recasted alloy was done for the years 2005–2023 using the following key phrases in various combinations: recasted alloys or casting or remelted or reused metal or recast% and cytotoxicity or gingival fibroblast cytotoxicity or cellular death or cell alterations and new alloy or fresh alloy, Cr-Co alloy, Ni-Cr alloy, or base metal alloy These terminologies were searched using the Boolean operators “AND” and “OR.” To narrow down the studies all the published literature was keenly examined through its reference list in the databases MEDLINE/PubMed/Webscience search.

Study inclusivity and data extraction

Two distinct authors (SB, NY) collected and extracted data in the current investigation using the Cochrane form for data collection on intervention. Extracted data from the inclusive study used for final result analysis. Through inclusion and exclusion the studies included were: (1) author and year of publication; (2) study design; (3) study group; (4) outcome parameter; (5) intervention; (6) results; and (7) inference.

Risk of bias assessment^[20]

The “The MINORS tool” was developed to evaluate risk of bias. The tool assessed the randomization and validity of the study. The risk of bias was assessed using eleven domains. (1) A clear target, (2) a digital cytotoxicity assessment technique, (3) sample size validation, and (4) sample randomization. (5) A description of recasted alloy fabrication, (6) test group materials, (7) standardization measurements, and (8) method of measuring. (9) Measurement reproducibility, (10) appropriate statistical analysis, and (11) overall evaluation.^[21]

Risk of bias evaluation by methodological index for non-randomized studies (MINORS) tool^[22]

The MINORS technique is a well-known instrument for evaluating bias in systematic reviews of *in vitro* studies. It is made up of prismatic particulars that evaluate various parts of the study design and reporting. These details include randomization, blinding, sample size calculation, and other variables that can affect the dependability of the results. The current investigation after regress assessment from the MINORS tool assess the quality through methodological implications in this systematic review and meta-analysis.

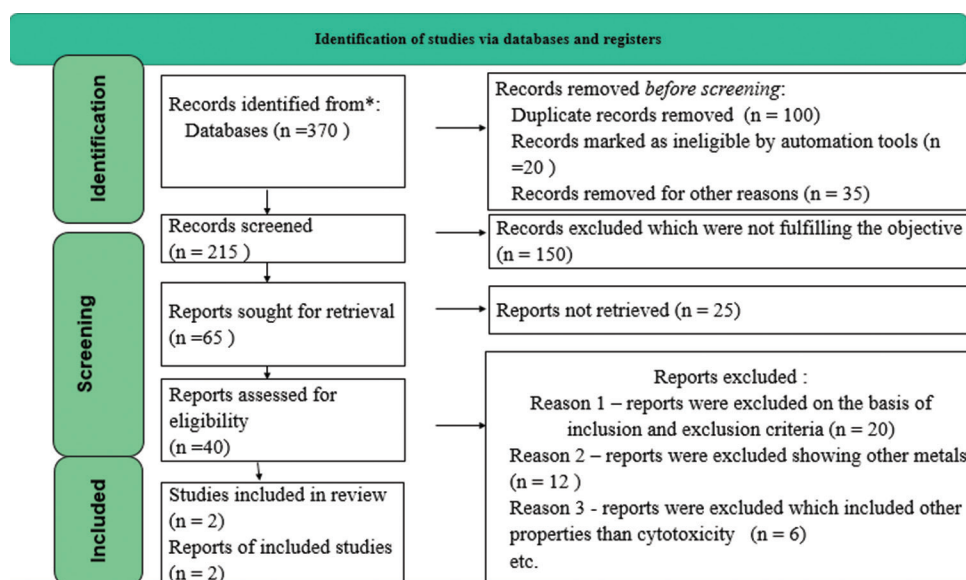


Figure 1: PRISMA chart

Methodological assessment of quality of studies included was analysed using the modified MINORS. The scale is made of 10 items, with the scoring of 0 for not reporting any item, 1 for inadequate reporting and 2 for adequate reporting. The maximum probable score for each study will be 20. Based on each items evaluated, a decision is made for the inclusion of the study [Figure 2].

RESULTS (ONLY FOR SYSTEMATIC REVIEWS AND META-ANALYSIS)

Study selection

The initial digital database hunts to identify possible publications. One hundred were removed based on duplicate records (20) and full text not available (35). The remaining 215 articles were screened. From these 215 articles, 150 were not excluded after evaluating their title and abstract. Following a full-text review of the remaining 65 articles, 25 were not retrieved out of 40, 20 were ruled out as per PRISMA guidelines of inclusivity, 12 were ruled out due to presence of other metal, six were ruled out because of different other properties. Resultant two articles published as per the study design were opted for further analysis (Table 1).

For the statistical outcome, all results were shown in a forest plot (Graph 1) based on standardized mean differences with a fixed-effects model to respect heterogeneity of these studies. To assess the heterogeneity of the different trials, I^2 -value was performed.^[22]

Comparison for the cytotoxicity between fresh alloy and recasted alloy was analyzed using Review Manager 5.4. The mean difference at 95% confidence interval and $P < 0.05$ was statically significant. A total of 46 samples in the fresh alloy category were compared with 46 in the recasted alloy section. Significant difference was noted for cytotoxicity with Recasted

alloy having a greater number of viable cells, at $P < 0.001$. A mean difference of -1.80 (95% CI: -2.64 ; -0.96) suggested that Recasted alloy had greater MMT level as compared to fresh alloy.

Statistical heterogeneity was assessed using I^2 test, which is 97% in the present analysis, indicating higher heterogeneity, and hence fixed effect model was run for the connotation of treatment effects.

Quality assessment of studies included

“The Evidence Project risk-of-bias tool” signifies the study rigors in RCTs and Non-RCTs. The tool evaluates the validity of trials for randomization and allocation of the studies. The risk of bias is evaluated using eleven domains: (1) Clearly stated aim, (2) digital method of measuring cytotoxicity, (3) validation of sample size, (4) sample randomization, (5) description of fabrication of recasted alloy, (6) test group material, (7) measurement of standardization, (8) measurement method, (9) measurement reproducibility, (10) adequate statistical analysis, and (11) overall appraisal.

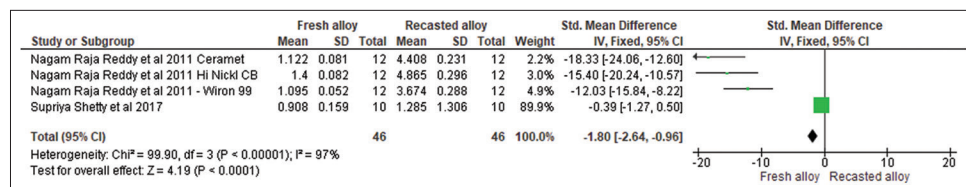
Statistical analysis

The present systematic review on reflection the cytotoxicity of recasted alloys and fresh alloys were investigated through this meta-analysis. The mean difference at 95% confidence interval was calculated and $P < 0.05$ was showing statistically significant results. The significance of the outcome as high cytotoxicity of the recasted alloys in comparison to fresh casted alloys, the difference was statistically significant. Review Manager (RevMan) (Computer Program) Version 5.4. Copenhagen: The Nordic Cochrane Centre, Denmark, The Cochrane Collaboration, 2020. Copenhagen: The Nordic Cochrane Centre, The Cochrane Collaboration, 2020 was used to analyze the effect generated in the forest plot. Data were collected from studies of different geographic regions. Thus,

Table 1: Studies published on recasting of alloys

Authors	Year	Study design	Study group	Outcome parameter	Intervention	Result	Inference
Shetty <i>et al.</i> [24]	2017	<i>In vitro</i> study	Disk-shaped specimens (1 × 2 mm, n=40) of cobalt chromium alloys were prepared with 100% new alloy and 50%, 30%, and 15% once recast alloy. 10 specimens from each group were conditioned in 0.5ml of saline (0.9% NaCl) containing 3% bovine serum albumin. Cytotoxic effects were assessed on human gingival fibroblast with (MTT) colorimetric assay a 3 dimethylthiazol. Collected data was statistically analysed with one way ANO comparison test fibroblast cytotoxicity was evaluated	The better mechanical properties and decreased cost, Co-Cr base metal alloys have gradually substituted gold alloys in the manufacture of fixed metal ceramic restorations. Presently, wide number of commercial dental laboratories are using recast alloy (used once or more times) either alone or by combining fresh metal ingots for fabricating dental prosthesis, considering only cost factor of the alloy, with no regard to manufacturers guidelines or changes in its properties on reusage	Cytotoxicity of dental alloys	Effects of alloy type on MTT activity and NRU assay depend on the amount of recasted alloy ANOVA. <i>Post hoc</i> multiple comparison tests were performed to determine how casting procedures affect MTT activity NRU assay of HGF cells. Tukey's MTT activity and NRU assay was significantly different for each casting procedure group (<i>Post hoc</i> comparisons of the 4 casting amount in the alloy.	Recasting of cobalt chromium alloys increased cytotoxicity and decreased cell viability of human gingival fibroblasts
Reddy <i>et al.</i> [23]	2011	<i>In vitro</i> study	Three Ni–Cr alloys [Wiron 99(A), Ceramet (B), and Hi Nickel CB (C)] were tested. Alloy specimens (disks 3 9 5 mm) were casted and grouped as follows: Group I (A1/B1/ C1): 100% pure alloy; Group II (A2/B2/C2): 50% new with 50% recast; and Group III (A3/B3/C3): 100% recast	Degree of cytotoxicity and biocompatibility of dental casting alloys has been related to alloy composition and elements released from alloys into surrounding medium. Recasting of Ni–Cr alloys increases the amount of elements released and hence the cytotoxic potential.	Cytotoxicity of recasted alloy	Elemental release was seen in all three casting alloy groups. Elements released were Ni, Cr, Co, Cu and Mo. Hi Nickel CB had the highest amount of elemental release among the three casting alloys followed by Ceramet and Wiron 99. Elemental release significantly increased with the percentage of recast material used in for all elements analyzed in the study with $P=0.05$	Recasting of base metal alloys affect their elemental release and subsequently elicit cytotoxic effects. Though it has been acceptable to reuse 50% re-casted alloy in the form of sprues removed from previous castings added to new alloy ingot to maintain physical and chemical properties, the elemental release from these re-casted alloys are significantly more and hence will have a definite cytotoxic effect

NRU: Neutral red uptake, HGF: Human gingival fibroblasts

**Graph 1: Forest plot for cytotoxicity of recasted alloy**

assuming statistical heterogeneity, a fixed effect model was preferred over random effect reduce heterogeneity of the study in meta-analysis of included studies.

Study characteristics

Out of two experiments contained in one, a computerized milling machine was used to mill an aluminum metal die with

a circular area of 5 mm radius and 3 mm depth in the center of a 1-cm thick aluminum block. The metal die was used to create wax designs measuring 10 mm in diameter and 3 mm in thickness using green inlay casting wax (Bego-Germany). This *in vitro* study looked into the consequences of recasting Ni–Cr base metal alloys, including their potential cytotoxic effects and elemental leakage into culture medium. The objectives of the

Checklist	Reddy <i>et al.</i> ^[23]	Shetty <i>et al.</i> ^[24]
Clearly stated aim	2	2
Digital method of measuring cytotoxicity	2	2
Validation of sample size	2	2
Sample randomization	2	2
Description of fabrication of recasted alloy	2	2
Test group material	2	2
Measurement of standardization	2	2
Measurement method	2	2
Measurement reproducibility	2	2
Adequate statistical analysis	2	2
Overall Appraisal	Include	Include

#0: Not reported, 1: Inadequately reported, 2: Adequately reported

Figure 2: Minors scores of study included

study were to evaluate the elemental release and cytotoxicity of Ni-Cr alloys, as well as to connect elemental release with cytotoxicity of pure alloy (Group I), 50% pure, 50% recast (Group II), and 100% recast (Group III) alloy.^[23] The second investigation used ten 1 × 2 mm iron disks manufactured in an engineering workshop and placed in a plastic tray. They were poured with silicone-based duplicating material (Bego), let to set, and then removed from the trays. This resulted in 10 cavities that mirrored the size and shape of the iron discs and served as molds for the creation of wax patterns with Inlay wax (Bego). The manufacturer's instructions were then followed for sprue preparation, investment, burnout, and casting. Co-Cr (Bego-Wironit) alloys were cast using phosphate-bonded investment (Bego) using a typical lost wax method. All finishing and polishing techniques were intended to replicate clinical cast-metal alloy preparation. For each alloy type, four varying concentrations of casting procedures were tested fresh alloy to amalgamation of recasting, with the percentage of new and recast alloy varying: each sample size of ten ($n = 10$) contained 100% new, 85% recast with 15% new, 70% recast with 30% new, and 50% recast with 50% new. In both experiments, cytotoxicity was determined by the proliferation of viable cells on the MTT assay.

Risk of bias assessment

The modified MINORS research was used to assess the methodological quality of the included research. The scale for quality assurance by assessing risk of bias is used consisting of ten-item scale, with scores of zero for not reporting any item, one for insufficient reporting, and two for adequate reporting. The highest possible score for each study will be 20. Based on each item reviewed, a choice is taken to include the study in the present meta-analysis.

DISCUSSION

The primary goal of this systematic review and meta-analysis was to collect and synthesize information from the existing literature on the impact of recasting base metal alloys on cell toxicity.^[25] Metals have historical been used in dental

restoration techniques. Dental casting alloys used to restore lost tooth structure should be physiologically inert. Metallic element leaking from dental casting alloys is a possible health risk.^[26] It is well established that hazardous metals leach from casting alloys, causing inflammatory, allergic, or mutagenic reactions. Nickel and chromium combine to make a highly corrosion-resistant alloy. These nickel-based base metal alloys are less expensive, have a higher elastic modulus (stiffer), are tougher and less dense, and have comparable resistance to tarnishing and corrosion. Permutation of nickel and chromium being more resilient, cost effective with a high modulus of elasticity in comparison to other metals and combinations.^[27,28]

Three elements influence selection physical advantages, biocompatibility, and cost are three elements that determine the choice of an alloy for certain applications, such as restorative or base metal for rehabilitative procedures in permanent or partial dentures. The gold alloy, regarded as a high noble metal, was the favored material for restorative procedures, and it was supposed that no ions leached from it, but histology examinations revealed otherwise. Due to the prohibitive cost of gold, dental casting alloys made of basic metals have emerged. Nickel and chromium combine to make a highly corrosion-resistant alloy. These base metal alloys are commonly used in nickel-based alloys because they are less expensive than gold alloys, have a greater elastic modulus (stiffer), are tougher, less dense, and exhibit equivalent tarnish and corrosion resistance to the gold standards.^[23-25]

The allowable leaching of these elements should be assessed to reduce adverse side effects (cytotoxic effects) during functional operations of the restorative or rehabilitative dental prosthesis.^[29] To further reduce costs, preventing depletion the casted alloy has been reused in varying amounts with new alloy. The elemental release of this recast alloy may differ from that of the pure virgin alloy. The biocompatibility of an alloy is determined by the type and quantity of elements discharged into the surrounding medium or tissues.^[30] To ascertain the element released from the alloys, and to determine its toxicity or health hazard, place the alloy in a suitable media, such as artificial saliva, for 3 months to evaluate the elements liberated from the alloy. Incubating in the suitable culture media for 3 days is a more feasible approach to quickly check the release of elements and the health consequences of the same. Storing the specimen in culture medium and incubating it is a more practical procedure because it takes less time and generates higher-quality results.^[31,32]

Furthermore, several methods have been proposed to determine the amount of elements released by incubating the metal, alloy in different combinations and permutations into the medium, including atomic absorption spectrography, emission spectrography, inductively coupled plasma atomic emission spectrophotometer, and inductively coupled plasma mass spectrometry (ICPMS).^[33] ICPMS is a multi-element analytical technique that is fast, sensitive, precise, and accurate for determining trace elements. Shetty *et al.*^[24] stated that base

metals have gradually replaced gold-casting alloys due to identical physical qualities. Ni-Cr alloys are the most popular base metal alloys for fixed partial dentures. The composition of these alloys varies depending on the manufacturer, but the main constituents are Ni, Cr, and M. Furthermore, for cost reasons, many dental laboratories mix already cast metal with new alloys. The chemical composition, microstructure, physical properties, and cytotoxicity of the alloys all change during the casting process. They have cytotoxic effects on surrounding tissue, and the amount of tissue reaction is determined by the elements released. Millipore filters, Agar overlay tests, and MTT assay tests are some of the most often used methods for measuring cytotoxicity. The MTT Assay is a straightforward procedure; readings can be assessed instantly using the ELISA reader. Other recompenses of MTT are its sensitivity and reproducibility, ease of use, and the elimination of the need for radioactive chemicals.^[34,35] Various conditioning solutions have been used in various studies to mimic the oral environment *in vitro*. In this investigation, the conditioning solution was saline with bovine serum albumin. This decision was made based on prior findings that protein-containing solutions increase alloy corrosion and that corrosion is essential for biological implications to effects adversely solution-containing proteins cause accelerated alloy deterioration.^[27,36] Dental alloys can remain in the intraoral environment for many years; therefore, it is critical to understand what occurs when they are exposed for an extended period of time. The indirect contact method was employed in the current study to cure cast alloys and administer extracts to gingival fibroblasts. This approach can be used to evaluate the effects of extended fibroblast exposure to conditioning media.^[27,36]

According to Wataha *et al.*,^[25-28] the indirect methodology is the most effective method for this type of examination. Fotakis and Timbrell^[37] conducted a study to evaluate four *in vitro* cytotoxicity tests and their capacity to detect early cytotoxic events. In conclusion, the neutral red and MTT assays were more sensitive in detecting cytotoxic events than the LDH leakage and protein assays. The MTT colorimetric assay and neutral red assay were used to determine cell mortality induced by corrosion products released from test alloy specimens. The amount of mitochondrial activity after incubation was utilized to assess the impact of the various extracts. For each cell type, a linear relationship between cell number and absorbance is established. The neutral red uptake (NRU) assay measures the number of viable cells in culture. It is based on the ability of living cells to absorb and bind the supravital dye neutral red in their lysosomes. When compared to the control, all four alloy groups had a statistically significant decrease in viable cell count. However, as compared to the control group, cytotoxicity for 100% new metal alloys and 50% reused alloys was not significant in either test. The effects of alloy on MTT activity and NRU test depend on the amount of recast alloy added ($P = 0.001$), indicating that the amount of recast alloy changed the cellular activity of human gingival fibroblasts. A reduction in the amount of recast alloy increases cellular

activity while minimizing cytotoxicity.^[38-40] Imirzalioglu *et al.*^[9] found similar results to the current study, namely, that adding recast alloy reduced the cellular activity of all assessed alloys ($P = 0.001$). According to research, increasing the chromium concentration in base metal alloys improves corrosion resistance. Imirzalioglu *et al.*^[9] reported that CoCr alloys with higher chromium concentrations produced less chromium than cobalt and exhibited less severe cytotoxic effects than Ni-Cr alloy subgroups. Ameer *et al.*^[41] It should also be mentioned that Co-Cr alloys have superior corrosion resistance than Ni-Cr alloys, even after repeated use. The most plausible explanation is that when chromium comes into contact with oxygen or moist conditions, it forms a passive oxide layer that disrupts the corrosion circuit. Al-Hiyasat and Darmani *et al.*^[30] discovered that Co-Cr alloys (Wirobond C) produced more cobalt than Ni-Cr alloys (RemaniumCS and Wiron 99). They further suggested that the cytotoxicity of this alloy was due to increased cobalt release, which is more toxic than nickel. The current study discovered that Co-Cr alloys were more cytotoxic than control groups for each casting procedure. Metal ions from various dental restorations are now known to discharge and infiltrate enamel, dentin, and gingiva, causing local symptoms.^[42,43] Endo *et al.*^[44] discovered that protein in the conditioning solution promoted early corrosion of Ni-containing alloys. According to the findings of this study, large amounts of nickel were liberated after 168 h of conditioning with a Ni-containing pH 5.4 solution containing albumin. Nickel is a known allergen, and the use of nickel-based materials in dentistry has been associated to allergic reactions. It has been demonstrated that the risk of nickel sensitization varies with the amount of nickel released over time. According to Al-Hiyasat *et al.*,^[45,46] all of the basic metal alloys studied were cytotoxic. CB Soft was the most cytotoxic of the Ni-Cr alloys, far more so than Remanium CS or Wiron 99. This could be because the composition of different alloys varies. Remanium CS and Wiron 99 include Cr (26% and 22.5%, respectively) and Mo (11% and 9.5, respectively), but CB Soft contains only a trace of Cr (4.9%) and no Mo. The combination of Cr and Mo in Ni-Cr alloys boosts corrosion resistance by forming a surface oxide layer. Only Ni-Cr alloys with 16–27% Cr have been shown to create a suitable protective oxide layer. Mo is also important in the formation of the protective oxide layer. Thus, increasing the concentration of Cr and Mo on the surface layer may synergistically reduce metal dissolving rates, thereby lowering alloy cytotoxicity. This is consistent with the results of the current study, which found that CB Soft released significantly more elements than Remanium CS and Wiron 99, presumably contributing to its greater cytotoxic effect. Significant variations in elemental makeup were seen when a Type III gold alloy was cast as 100% new, 50% new with 50% recast, or 100% recast alloy. Indeed, when 50% recast alloy was compared to 100% new cast alloy in a Ni-Cr alloys study, Ni release into lactic acid and NaCl solution increased. Another study found that recasting Ni-Cr and Co-Cr alloys 4 times did not significantly improve corrosion resistance. The cytotoxicity of the base metal alloys examined in this study

was significantly raised by recasting the alloys at 50% and 100% levels. This was owing to the composition and quantity of elements released by these alloys. Furthermore, the amount of element release increased proportionally with the number of recast alloys employed.^[47,48]

According to Reddy *et al.*^[23] three Ni-Cr-based alloys (Wiron 99, Ceramet, and Hi Nickel CB) are commonly utilized in the construction of metal-ceramic fixed partial dentures from various popular manufacturers. In this study, element release was much lower in all fresh alloy samples than in re-casted specimens. Among the three alloys tested, Hi Nickel CB released significantly more elements than Ceramet and Wiron 99 in pure alloy, 50% recast, and 100% recast alloys. Wiron 99 released the least amount of element in 100% pure alloy, 50% recast, and 100% recast specimens. All of the base metal alloys examined in this investigation were found to be cytotoxic. In the cytotoxic evaluation done by analyzing living cells and percentage of cell viability, it was seen that in 100% pure alloy specimens Wiron 99, Ceramet, and Hi Nickel CB were cytotoxic in the increasing order. With recasting of alloys, either with 50% or 100% showed a definite decrease in the number of living cells in all the three alloys. In the present study in 50% new–50% re-casted and 100% re-casted, the mean of living cells and percentage of cell viability are more significant in Wiron 99 than Ceramet and Hi Nickel CB. Hi Nickel CB showed the least number of viable cells.^[29]

All of the fresh alloy samples in our investigation had substantially less element release than the recast specimens. In the pure alloy, 50% recast, and 100% recast alloy tests, Hi Nickel CB released noticeably more elements and Wiron 99 produced the least amount of element. It was discovered that every base metal alloy that was looked at in this study was cytotoxic. Through the analysis of living cells and percentages of cell viability, the cytotoxic examination of 100% pure alloy specimens revealed that Wiron 99, Ceramet, and Hi Nickel CB were cytotoxic in increasing order.

CONCLUSION

The study's conclusions provided credence to the theory that recasting base metal alloys influences elemental release and, consequently, cytotoxicity. Despite this, the element release from these re-casted alloys is significantly higher and therefore has a distinct cytotoxic effect within the confines of the current investigation, even though it is acceptable to reuse 50% recasted alloy in the form of sprues taken from prior castings and added to new alloy ingot to retain physical and chemical qualities. All tested alloys had higher cellular activity when recast alloy was added ($P = 0.001$). Considering that reusing base metal alloys increases their cytotoxicity.

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