ISSN: 2581-5989
PubMed - National Library of Medicine - ID: 101738774

International Journal of Dental Science and Innovative Research (IJDSIR)

IJDSIR : Dental Publication Service

Available Online at: www.ijdsir.com

Volume – 3, Issue – 1, February - 2020, Page No. : 412 - 418

Comparative Evaluation of Marginal Accuracy of Castings Fabricated By Conventional Casting Technique and Accelerated Casting Technique Using Nickel Chromium Alloy and Cobalt Chromium Alloy-An In-Vitro Study

[1]Dr.Ashish Kumar Rathod, Department of Prosthodontics, Bharati Vidyapeeth Dental College and Hospital, Pune

[2]Dr.Vijaysinh More, Department of Prosthodontics, Bharati Vidyapeeth Dental College and Hospital, Pune

Corresponding Author: [1]Dr.Ashishkumar Rathod, Department Of Prosthodontics, Bharati Vidyapeeth Dental College and Hospital, Pune

Citation of this Article: Dr. Ashish Kumar Rathod, Dr. Vijaysinh More, " Comparative Evaluation of Marginal Accuracy of Castings Fabricated By Conventional Casting Technique and Accelerated Casting Technique Using Nickel Chromium Alloy and Cobalt Chromium Alloy-An In-Vitro Study", IJDSIR- February - 2020, Vol. – 3, Issue -1, P. No. 412 – 418.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Background: Conventional casting technique is time consuming when compared to accelerated casting technique. In this study, marginal accuracy of casting fabricated using accelerated and conventional casting technique using nickel chromium and cobalt chromium alloy was compared.

Materials and Methods: 60 patterns were fabricated and the marginal discrepancy between the die and patterns were measured using optical stereomicroscope. 30 wax patterns were used for conventional casting and rest for accelerated casting. A Nickel-Chromium alloy and Cobalt-Chromium alloy was used for the casting. The castings were measured for marginal discrepancies and compared.

Results: Castings fabricated by Conventional casting technique using Cobalt-Chromium alloy showed less vertical marginal discrepancy than the castings fabricated by Conventional casting technique using Nickel-Chromium alloys. The values were statistically significant.

Conclusion: Conventional casting technique using Cobalt-Chromium alloy produced better marginal accuracy when compared to Conventional casting technique using Nickel-Chromium alloy. The vertical marginal discrepancy produced by the Accelerated casting technique using Nickel-Chromium and Cobalt-Chromium alloy was well within the maximum clinical tolerance limits.

Clinical Implication: Accelerated casting technique can be used to save lab time to fabricate clinical crowns with acceptable vertical marginal discrepancy and use of Cobalt-Chromium alloy for the patient that have Nickel-Chromium allergy.

Keywords: Accelerated casting, conventional casting, marginal accuracy, phosphate-bonded investment.

Introduction

Although, the "Lost wax" technique has been used since ancient times, it has become a common practice in dentistry after it was introduce by William H. Taggart in 1907. [1]

Conventional casting technique which is routinely used in dentistry usually requires at least 1 h for the investment to set, followed by a one or two stage wax elimination procedure before casting is done. This procedure is time consuming and requires approximately 2-4 for completion. [1-3]

Accelerated casting technique has been reported to achieve similar quality results in significantly less time, namely in 30-40 min for the fabrication of High noble alloys crowns.[1-3]

Nickel alloy contribute to the chronic inflammatory reactions and also cause allergy in some patients these risks can be minimized by selecting alloys with relatively low Ni2 release. Dental interest in Co-Cr has increased due to its low price and is considered as good alternative to nickel chromium alloy. [4]

This study evaluated the marginal accuracy of full coverage single crown made with an accelerated and conventional casting technique that uses phosphate bonded investment material and a Nickel-Chromium (Ni-Cr) and Cobalt-Chromium (Co-Cr) alloy.

Materials and Methods

The study was conducted in Department of Prosthodontics, Crown and Bridge and Implantology, Bharati vidyapeeth Dental College and Hospital Pune.

A stainless steel die assembly was used to fabricate standardized wax patterns. The master die {figure1} simulated a crown preparation with 6-degree total axial wall taper. The axial height of the die and its occlusal diameter were 6mm and the finish line was a 90-degree shoulder, 1 mm with the width. Occlusal cross hairs were placed for precise wax pattern repositioning . the die could be accurately positioned in a stainless steel former { counter die} that had an opening in the centre 1 mm larger than the die in all dimensions{figure 1}

Wax pattern { Bego,germany} were fabricated on the master die by closing the counter die until the demarcated mark over the die to obtain a wax pattern of uniform thickness . the margins were readapted and divided into 4 groups with 15 wax patterns in each group.

- Group I : Ni-Cr copings fabricated by conventional casting technique
- Group II Ni-Cr copings fabricated by accelerated casting technique
- Group III : Co-Cr copings fabricated by conventional casting technique
- Group IV : Co-Cr copings fabricate by accelerated casting technique

The wax patterns were spurred. Wax patterns were invested individually with individual casting rings lined with a ceramic ring liner. They were invested with bellasum { bego, germany} phosphate bonded investment { 60g of powder to 16 ml of 100% mixing liquid)

Group I and Group II: The investment was allowed to set for 2-3h. Then the casting ring was placed in a burnout furnace at room temperature and the temperature was raised to 250c and maintained for 60 min. Thereafter the temperature was raised to 90 c and held for 30 min\

Group II and Group VI: The Investment was allowed to set for 13-17 min, immediately the casting ring was placed in burnout furnace at a pre-heated temperature of 815C for 15min.

After the completion of the burnout ,the casting procedure was carried out in an induction-casting machine using Ni-Cr alloy (Wiron99,Bego,Germany) and Co-Cr alloy.The casting were recovered [figure 2],burs were used to remove the investment from the inner surface of the

casting such as a thin layer of investment was left behind sandblasting was done to remove the residual investment and oxide layer.

The completed casting were seated on the metal die under finger pressure [Figure 3].The marginal discrepancy between the metal die and the castings were measured [table 1] on an optical stereo microscope at predetermined points using Pro-Plus software [Figure 4].

All measurements were executed by a single operator and the reading were tabulated and used for the statistical analysis (student's unpaired t-test was used).The marginal accuracy of castings were compared with the conventional and Accelerated castings using Nickel and Chromium and Cobalt Chromium ally[Tables 1 and 2].

Table 1

GROUP : I							GROUP : II					
S.N.	Sample ID	Marginal Gap (µm)					S.N.	Sample ID	Marginal Gap (µm)			
		0º	90º	180º	270º				0º	90º	180º	270º
1	No.1	363	356	242	222		1	No.1	80	67	95	76
2	No.2	294	217	201	210		2	No.2	188	205	167	290
3	No.3	181	219	190	197		3	No.3	130	158	118	127
4	No.4	140	95	120	124		4	No.4	189	196	99	109
5	No.5	163	135	238	180		5	No.5	48	46	73	65
6	No.6	284	270	139	168		6	No.6	193	198	215	196
7	No.7	272	215	125	190		7	No.7	123	106	139	144
8	No.8	117	111	180	115		8	No.8	85	80	94	90
9	No.9	261	207	201	195		9	No.9	243	215	370	285
10	No.10	123	180	165	190		10	No.10	267	190	170	155
11	No.11	240	255	225	205		11	No.11	260	220	235	205
12	No.12	184	276	219	151		12	No.12	188	178	155	170
13	No.13	230	205	170	175		13	No.13	312	268	185	230
14	No.14	184	215	200	101		14	No.14	230	205	169	190
15	No.15	119	102	103	106		15	No.15	100	35	108	98

Table: 2

GROUP : III							GROUP : IV					
S.N.	Sample ID	Marginal Gap (µm)					S.N.	Sample ID	Marginal Gap (µm)			
		0º	90º	180º	270º				0º	90º	180º	270º
1	No.1	107.3	115	35	85		1	No.1	129	116	150	140
2	No.2	339	237	190	124		2	No.2	130	89	48	120
3	No.3	158	216	154	143		3	No.3	165	128	80	101
4	No.4	185	57.9	115.9	89		4	No.4	93.3	144.8	90.1	88.2

5	No.5	43.4	129	283	129		5	No.5	195	254	211.6	158
6	No.6	160	98	70.8	90		6	No.6	290	160	200	170
7	No.7	58.8	211	79.6	38		7	No.7	116	0	35	40
8	No.8	58	184	131	142		8	No.8	80	90	78	82
9	No.9	131	100	63.2	70		9	No.9	153	132	183	106
10	No.10	130	112	121	98		10	No.10	324	273	200	280
11	No.11	369	243	263.2	136		11	No.11	95	48	39	36
12	No.12	160	180	96	120		12	No.12	150	125	130	95
13	No.13	119	154	98.2	102		13	No.13	127	98	108	89
14	No.14	130	93	93	25		14	No.14	137	216	322	253
15	No.15	160	102	80	65		15	No.15	156	133	90	42

Results

The castings fabricated by Cobalt-chromium alloy using conventional casting technique showed less vertical marginal discrepancy (131.17) than the castings fabricated by Nickel-Chromium alloy (191) using conventional casting technique (Group I < group III). The values were statistically significant (p-value < 0.05).The marginal discrepancy of the 15 castings fabricated by accelerated casting technique using nickel chromium alloy (group II) showed a mean value of 163.75µm.

The marginal discrepancy of the 15 castings fabricated by accelerated casting technique using cobalt chromium alloy (Group IV) showed a mean value of 135.20 µm.

Discussion

Factors affecting the success of an FPD are multiple and complex. Marginal integrity is one such factor which influences the longevity of the final prosthesis in the oral cavity[5]. Clinical acceptability and longevity of cast restorations is related to marginal fit[6]. This has been shown to be clinically significant to the periodontal health and the development of recurrent marginal caries. Clinically, a cast alloy crown can be regarded as a good fit if it has sufficient axial tolerance to allow seating and if its margin is congruent with the cavo-surface line angle of the tooth preparation as judged by visual and tactile examination.[7]

The marginal fit of castings basically relies on precise tooth preparation, accurate impressions and precision during casting procedures.Schwartz et al cited defective margins are a frequent cause (11.3%) of unserviceable crowns and fixed partial dentures. Grasso et al reported that 30 to 40% of crown margins were inadequate, often because of poor marginal integrity. Recent studies continue to demonstrate high rates of marginal deficiencies and indicate that defective margins are responsible for over 10% of failed units.

The primary physical-chemical properties of base metal alloys include a lower density than gold alloys, a particularly useful feature in fabricating less bulky prostheses, and a modulus of elasticity that is nearly twice that of gold alloys, providing fixed and removable partial dentures with the advantage of maintaining rigidity with less bulk. These properties allow for improved esthetics and physiological contouring and the development of a suitable occlusion with less tooth structure reduction. More recently, improvement in alloy composition and development of new manufacturing techniques have optimized the use of these alloys and therefore were considered suitable for the present study.However nickel

has been identified as one of the major contact allergens worldwide. Therefore, the European Union (EU) restricted its use in consumer products. As a result nickel allergy among young patients showed a decline in several countries such as Germany, Sweden and Denmark[8].

C. M. WYLIE AND A. J. DAVENPORT (2010), did study on adverse reaction of oral mucosa to nickel-based dental casting alloys due to corrosion ion release. While dental alloy Ni^{2+} release into culture medium is relatively low, the prolonged contact of the Ni alloy with the oral epithelium may contribute to the chronic inflammatory reactions seen in some patients[9].

Anders Örtorpa, David Jönssonb, Alaa Mouhsenb, Per Vult von Steyern(2010), did evaluation and comparison of cobalt chromium alloy. Dental interest in Co–Cr has increased due to its comparable price and is considered as good alternative to nickel chromium alloy. However, there are few published studies on properties such as biocompatibility and marginal fit on FDPs for this material and its fabrication methods . Several techniques of using a Co–Cr for fixed prosthodontics are available today. Studies also show that the longer the FDPs are, the larger is the risk of distortion. In addition, the heavier a metal construction, the more distortion is present. The latter is probably not a risk for cobalt–chromium (Co–Cr) constructions because of their low weight.[10]

This study focused on investigating the differences in marginal accuracy of cast crowns made of conventional and accelerated casting technique using nickel chromium and cobalt chromium alloy. In this study the marginal discrepancies were measured at 4 predetermined points (0, 90,180 and 270). More number of reference points for marginal gap measurements for each coping could yield a better confirmative result.

The Null Hypothesis of this study stated that there is no significant difference between the marginal accuracy of Ni-Cr and Co-Cr castings using accelerated and conventional casting technique.

The marginal discrepancy was observed using Stereo Microscope and an Image analysis software

The statistical analysis is as follows:-

1. There was no significant difference between conventional and accelerated casting technique fabricated by nickel chromium alloy as unpaired t-test demonstrated p-value >0.05.
2. There was no significant difference between conventional and accelerated casting technique fabricated by cobalt chromium alloy as unpaired t-test demonstrated p-value >0.05.
3. There was significant difference between nickel chromium and cobalt chromium alloy using conventional casting technique as unpaired t-test demonstrated p- value <0.05.
4. There was no significant difference between nickel chromium and cobalt chromium alloy using accelerated casting technique as unpaired t-test demonstrated p- value >0.05.

These results are not inline with a study conducted by Katta Sridhar Chowdary where in the marginal accuracy of the Ni-Cr was found better than that of Co-Cr. A similar study was conducted by Pavan Kumar Tannamala et.al, they compared the conventional and accelerated casting techniques using Ni-Cr alloy and found that a statistically significant difference was found between both the techniques but the mean marginal discrepancy was within clinically permissible limits[11].

This difference in the marginal discrepancy in this study and the study conducted by Pavan Kumar maybe due to the use of beryllium free Ni-Cr alloy in this study. As noted by David Duncan Ni-Cr alloys containing beryllium appeared to have a lower casting temperature, less casting

shrinkage, better casting accuracy and less variation of results than Ni-Cr alloys not containing beryllium[12].

A study by Bronson MR et,al checked the clinical acceptability of crown margins versus marginal gaps. The gaps ranged from 40µm-615 µm thus the marginal discrepancy found in this study of all the groups is well below the range of marginal gap suggested by Bronson. On reviewing the literature no studies were found wherein Co-Cr alloy was used with accelerated casting technique. [13]

Following are the limitations of this study

1. Prior to casting, wax pattern were not evaluated for discrepancy under microscope, as discrepancy in wax pattern can ultimately replicate in the final copings.
2. The study was conducted using stone die that had even margin and the wax pattern fabricated over the stone die was also of even thickness along with even margin. But in long term clinical practice, it is very difficult to obtain such even margin on tooth and even thickness of wax pattern over die that may affect the final accuracy of the casting.
3. Polishing and finishing of the casting was done manually which may also create some discrepancy in the casting.
4. This study was conducted over a period and environmental temperature may also have influence on the fabricated wax pattern.

Conclusion

The order of discrepancy values of marginal gap of the cast copings in the study is as follows:-

A. Minimum marginal gap- cobalt chromium copings using conventional casting technique (Group III) **131.17 µm.**

B. Maximum marginal gap- nickel chromium copings using conventional casting technique (Group I) **191µm**.

The comparative statistical analysis of maximum vertical marginal discrepancy was seen in **GroupI** and minimum seen in **Group III**.

References

1. Konstantoulakis E., Nakajima H., Woody R.D., Miller A.W.: Marginal fit and surface roughness of crowns made with an accelerated casting technique. J Prosthet Dent; 80:337-45. 1998.
2. Schilling ER, Miller BH, Woody RD, Miller AW, Nunn ME. Marginal gap of crowns made with a phosphate-bonded investment and accelerated casting method. J Prosthet Dent. 1999 Feb;81(2):129-34.
3. Blackman RB. Evaluation of the dimensional changes and surface roughness of gold crowns cast with rapidly prepared phosphate bonded investment: a pilot study. J Prosthet Dent 83:187–193.
4. Wylie CM, Davenport AJ, Cooper PR, Shelton RM. Oral keratinocyte responses to nickel-based dental casting alloys in vitro. J Biomater Appl. 2010 Sep;25(3):251-67.
5. Bronson MR, Lindquist TJ, Dawson D. Clinical Acceptability of Crown Margins versus Marginal Gaps as Determined by Pre-Doctoral Students and Prosthodontists. J Prosthodont 2005;14:226-232.
6. Jahangiri L, Wahler C, Hittelman E, Matheson P. Assessment of sensitivity and specificity of clinical evaluation of cast restoration marginal accuracy compared to stereomicroscopy. J Prosthet Dent 2005;93:138-42.
7. Junner RE, Stevens L. Anisotropic expansion of phosphate-bonded investment. Aust Dent J 1986;31:6434-39.
8. Peiser M, Tralau T, Heidler J, et al. Allergic contact dermatitis: epidemiology, molecular mechanisms, in vitro methods and regulatory aspects: Current knowledge assembled at an international workshop at

BfR, Germany. Cellular and Molecular Life Sciences. 2012;69(5):763-781. doi:10.1007/s00018-011-0846-8.

9. Wylie CM, Davenport AJ, Cooper PR, Shelton RM. Oral keratinocyte responses to nickel-based dental casting alloys in vitro. J Biomater Appl. 2010 Sep;25(3):251-67.
10. Anders Örtorp , David Jönsson, Alaa Mouhsen, Per Vult von Steyern. The fit of cobalt–chromium three-unit fixed dental prostheses fabricated with four different techniques: A comparative in vitro study. Dental Materials Volume 27, Issue 4, April 2011, Pages 356–363.
11. Katta Shridhar Chowdary. Evaluation Of Marginal Fit Of Castings Made With Nickel-chromium And Cobalt-chromium Alloys Using Varying Coats Of Die Spacers - A Laboratory Study; IJDS Dec2011, Vol. 3 Issue 5, p4.
12. J. David Duncan. The casting accuracy of nickel-chromium alloys for fixed prostheses. JPD; Volume 47, Issue 1, January 1982, Pages 63-68.
13. Bronson MR, Lindquist TJ, Dawson D. Clinical Acceptability of Crown Margins versus Marginal Gaps as Determined by Pre-Doctoral Students and Prosthodontists. J Prosthodont 2005;14:226-232.

Legends Figures

Figure 1: Master Die with Counter Die

Figure 2: Recovered Group I, II, III and IV

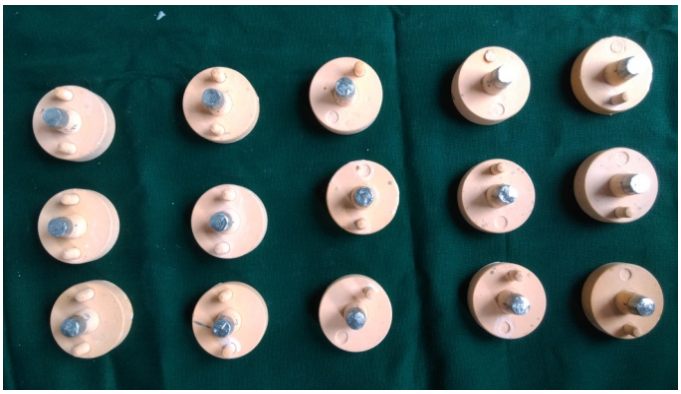

Figure 3: Castings Were Seated On Die

Figure 4: Marginal Discrepancy Checked Under Stereo-Microscope - Casting With Sprue Attached