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"A COMPARATIVE EVALUATION OF METAL RING INVESTING V/S RING LESS INVESTING TECHNIQUES AND EFFECT OF USE OF DIE SPACER ON THE MARGINAL FIT OF METAL CROWN" – AN IN-VITRO STUDY.

Dr. Anita Mahiwal	Medical officer, Govt hospital, Palwal Haryana.
Dr. Kusum Singh*	Associate Professor, Dept. of dentistry, Sardar Patel Medical College and Associated hospitals, Bikaner, Rajasthan. *Corresponding Author
Dr. Sumit Kumar Sharma	Junior Specialist, govt hospital
Dr. Garima Gothwal	Senior Resident, dept. of dentistry, Sardar Patel Medical College and associated hospital, Bikaner, Rajasthan

ABSTRACT **Aim-** To compare the marginal discrepancy of lost wax casting technique produced with the conventional casting technique using a metal ring vs. a ring less system and the effect of use of die spacer on the marginal discrepancy of full metal crown.

Method- Total 40 metal crowns are fabricated using a stainless steel die of the standard dimensions. These samples were divided into 4 groups, 10 samples in each group as follows Group-1: Crowns without die spacer, cast with metal ring. Group-2: Crowns without die spacer, cast with ring less casting. Group-3: Crowns with die spacer, cast with metal ring. Group-4: Crowns with die spacer, cast with ring less casting. Castings were seated on metal die after sand blasting; no other modifications were made to improve the seating. The marginal discrepancy measurement of the specimens were made using an Optical Microscope (Olympus BX-Model, Japan) at four locations marked on the die as well on the crown in the same alignment. These measurements were used for the statistical analysis by Student t' test.

Results- marginal discrepancies of Group-1, Group-2, Group-3 and Group-4 was found to be 187.07µm, 149.86µm, 106.91µm and 62.42µm respectively. No significant difference was observed between Group-1and Group-2. On comparison of the marginal discrepancies of Group-1 and Group-3 there was an expected improvement in marginal discrepancy ($p<0.01$). Marginal discrepancies of Group3 Group-4 showed expected improvement in marginal discrepancy ($p<0.01$). In marginal discrepancies of Group-2 and Group-4 there was highly significant improvement ($p<0.001$).

Conclusion - the lowest marginal discrepancy was obtained using ring less casting technique with die spacer (62.42µm) with a significant difference from the marginal discrepancy obtained without die spacer and with the metal ring casting technique.

KEYWORDS : Casting, ring less, investment, marginal discrepancy, die spacer.

INTRODUCTION

The accuracy of fit of a crown is affected by various factors like quality of the preparation (undercuts, taper of the preparation), accuracy of impression and the working cast, quality of the wax that is used for the lost wax technique, accuracy of the castings and space for the cementation[1]. In conventional casting technique investment is confined within the metal ring. Metal ring restricts the thermal expansion of investment because thermal expansion of metal ring is less than that of investment. To compensate this limitation, an asbestos ring liner was recommended, but now a days its use has been banned because of its carcinogenic effect. Paper ceramic liner is used as substitute[1].

Although the metal ring technique is clinically acceptable and allows for the fabrication of accurate casts, the metal ring restricts the setting and thermal expansion of the investment which is necessary to compensate for the shrinkage of the metal on solidification[1]. To overcome this expansion restriction, a ring less technique was introduced. Use of a ring less technique[2], the restriction of thermal expansion that is associated with the presence of the metal ring is avoided because it allows the investment to expand vertically as well as horizontally. The ring less technique is easier, less expensive, and gives clinically acceptable results. In the literature, there are few studies comparing the 2 casting techniques for fixed restorations. Seating of a complete crown during cementation can be improved by perforations or venting[3,4], good cementation technique[5] and providing internal relief[6,7] through;

- Internal Venting
- Etching the internal surface of cast restoration with aqua regia (Hollenbeck in 1920)
- Electrochemical milling of the inside of casting for 5-60 seconds[8,4]
- Die Spacer

Effect of die spacer[9-11]; A cast crown restoration must be made to fit the prepared tooth accurately. This, however, makes it difficult for the cement to escape from between the tooth and the casting, creating hydraulic pressure within the cement. Consequently, a crown may fail to seat properly. The incomplete seating may lead to post-cementation marginal gap, creation of premature contacts, alteration of contacts areas with the adjacent teeth and reduction in crown retention by19-32%. Therefore relief should be provided throughout the internal portion of a casting, but maintaining the integrity of an area 0.5 -1.0 mm short within the margin. A clinically acceptable relief considered to be is 20-40µm[12,13]. Use of Die Spacer allow increased space for cement between the tooth surface and internal surface of casting, reducing stress areas created during cementation thus provide better marginal fit and retention of final restoration Die Spacer available (TRU-FIT) contains very fine polymer particles suspended in acetone or other suitable solvent. Four thin coats of it provide 25 micron relief space under a crown. Die spacer helps in compensating the alloy's casting shrinkage by adding to the thermal expansion of the refractory material[13].

The present study was an in-vitro study carried out at the Govt. Dental College and hospital, Jaipur to compare the marginal fit of metal crown using ring investing v/s ring less investing and effect of use of die spacer on its fit.

AIMS AND OBJECTIVES;

- To compare the marginal discrepancy of lost wax casting technique produced with the conventional casting technique using a metal ring vs. a ring less system.
- To evaluate the effect of use of die spacer on the marginal discrepancy of full metal crown.

METHODOLOGY;

To carry out this study a stainless steel die of following dimensions was used as a standard die:

- Crown height-8mm
- Diameter at cervical margin-7mm
- Diameter at the occlusion surface-5.5mm
- Shoulder preparation-1.5mm

The study was carried on the total 40 samples, dividing into 4 groups, 10 samples in each group as follows:

- Group-1: Crowns on Die without die spacer cast with metal ring
- Group-2: Crowns on Die without die spacer cast with ring less casting
- Group-3: Crowns on Die with die spacer cast with metal ring
- Group-4: Crowns on Die with die spacer cast with ring less casting

The marginal discrepancy measurement of the specimens were made on the resulting gap using a Optical Microscope (Olympus BX-Model, Japan) at four locations marked on the die as well on the crown in the same alignment , at Birla Institute of Scientific Research (BISR), Jaipur

Application of die spacer:

In group 3 and 4, an even coat of tru- fit die spacer (George Taub Product & Fusion co. inc. Jersy city, New Jersey) was applied on stainless steel die to completely cover the occlusion and axial surface of preparation to within the 0.5-1mm of cervical margins to ensure the maximum adaptation in these critical areas.

By varying the number of coats different amount of relief was produced on the internal surface of casting. Four alternative coats of die spacer, first a thin coat of the silver varnish was applied, then a coat of gold layer was applied to give a relief space of **approx. 20-28µm.**

Wax pattern fabrication:

Working die and metal sleeve was first lubricated with die lubricant according to manufacturer's instructions and wax patterns were fabricated following the incremental technique. After application of each layer of Blue inlay wax (Bego), it was allowed to solidify and checked for proper thickness using the warm metal sleeve. The metal tube permitted the standardization of pattern thickness. After the wax cooling, the metal sleeve was removed. The wax margins were carefully cut back to finish line using a Holllenback instrument and were not re-melted before evaluation. The external margin of the crown pattern and the margin of the cervical preparation line of the master metal die made a butt joint and were in the same vertical plane.[8]

Investing Technique:

Investing of wax pattern was done immediacy after its fabrication.
For conventional casting system, a metal ring of 2.5 cm diameter and a ceramic paper liner (Bego wilh Herbst Gmbh Co, Bremen, Germany) wetted for one minute was used.

The wax patterns were sprued and rinsed thoroughly with surfactant (Sigmadent, S. K. Co., India) before investing. Each crown wax pattern was invested individually in one ring each for standardization immediately after its fabrication. These wax patterns were invested in a carbon-free, phosphate bonded investment (Deguvest Impact, Degu Dent gmbH, Germany) with a water / powder ratio of 20ml/80g, prepared in an electrical evacuating and mixing unit. The investments were hand mixed for 15 to 20 seconds, then mechanically mixed for 30 seconds using the Vacuum Investing Machine (Sirio Dental snc 47014 Meldola (FC), Italy) **&** poured in the ring without entrapment of air bubble. The investment was allowed to set for approx. one hour.

In ring less casting technique (group-2 and group-4) were invested following the same investing procedure as that of conventional casting system (Metal Ring Casting system) except that in this system wax patterns were invested in a 3cm removable plastic mould (Ring less).

Each "ring" was left in a dry pressure pot for 5 minutes. After initial setting (10 minutes) of investment the moulds of the ring less groups were removed from the plastic ring.

CASTING OF THE WAX PATTERN;

Burnout: In conventional casting technique the metal ring with invested wax patterns was placed in burnout oven (Toshiba, India) (10°C/1 min soak temperature 260°C and final soak temperature 815°C) for 45 minutes. The ring less mould was also placed in furnace at same time, temperature and under the same conditions.

Casting was done in the induction casting machine (Dentalfarm Torino-Italy) with casting alloys. After ring casting and cooling, the metal crowns were divested, sandblasted with 100 µm aluminum oxide, under a pressure of 80 lb/pol2 in an airborne-particle machine. Castings were cut from their button and seated on metal die to check seating and no other adjustment was made to improve restoration fit. Defective casting crowns were discarded. In this way a set of 40 crowns were selected without any modification**.**

Measurement of the marginal discrepancy;[13,14]

The master metal die was marked with four reference marks (mesial, distal, buccal, and lingual) using a fine pointed diamond point to allow for orientation and to identify the gap during measurements.

The marginal discrepancy measurement of the specimens were made on the resulting gap using an Optical Microscope (Olympus BX-Model, Japan) at four locations marked on the die as well on the crown in the same alignment. Total four images were taken for each crown corresponds to each surface. After that images were transferred to computer screen using the camera (Jai-CCD camera).Measurements were taken using the ***scion image corporation software*** (U.S.A.) and stage micrometer by the following equation:

Calibration= Conversion of pixels to µm (0.01mm=10µm=1division)
Each surface measured three times for a total of 12 measurements, adding to a total of 480 measurements and respective means of 12 measurements were done to obtain the true value of individual crown. Mean values of these measurements were used for the statistical analysis by applying student t' test.

Observations and Results ;
Table no. 1

N	Metal Ring without Die Spacer	Ring Less without Die Spacer	Metal ring with Die Spacers	Ringless with Die Spacers
1	164.66	197.58	98.33	90.13
2	191.33	117.99	74.66	72.16
3	140.83	90.49	123.82	50.83
4	126.33	196.33	115.49	39.49
5	194.58	202.33	76.99	35.33
6	270.83	107.83	199.33	69.49
7	168.99	139.32	204.16	49.16
8	145.16	152.84	95.33	67.66
9	233.49	144.82	95.33	85.33
10	234.49	148.16	67.16	64.16
Mean	187.07	149.86	106.91	62.42
Standard Deviation	47.03	38.94	48.93	18.37
N	10	10	10	10

Table 2

Serial No.	Variable	Mean	Standard Deviation	Confidence Interval
Group-1	Metal Ring Without Die Spacer	187.07	47.03	187.07 ± 47.03
Group-2	Ring Less Without Die Spacer	149.86	38.94	149.86 ± 38.94
Group-3	Metal Ring + Die Spacers	106.91	48.93	106.91 ± 48.93
Group-4	Ring Less + Die Spacers	62.42	18.37	62.42± 18.37

RESULTS; The results show that when we compare the marginal discrepancies of Group-1 (187.07µm) Vs. Group-2 (149.86µm) there were not any significant or an expected improvement in marginal discrepancy. ($p<0.10$)

On comparison of the marginal discrepancies of Group-1 (187.07µm) Vs. Group-3 (106.91µm) there was an expected improvement in marginal discrepancy. ($p<0.01$)

When comparison of the marginal discrepancies of Group3 (106.91µm) Vs. Group-4 (62.42µm) was done there was an expected improvement in marginal discrepancy. ($p<0.01$)

When we compare the marginal discrepancies of Group-2 (149.86µm) Vs. Group-4 (62.42µm) there was far better improvement in marginal discrepancy than expected. ($p<0.001$)

DISCUSSION;

Taggart first described the lost wax casting process in dentistry in 1907

and observed that resultant castings were undersized. The accurate fit of cast is essential for its longevity because it allows less plaque accumulation at marginal area, provides better mechanical properties (stability, resistance), less cement space (less possibility of leakage) and improves the esthetics result. when we compare the marginal discrepancies of casting[1,5] produced with the conventional casting technique using a metal ring without die spacer vs. ring less casting system without die spacer, we find that there is less marginal discrepancy with ring less casting technique ***(149.86***µm) as compared to metal ring casting technique ***(187.06***µm) and are statistically significant at p<0.10 The results are consistent with those reported by **Lombards et.al.** In this study, it could be observed that there was significant difference for the interactions among the analyzed variation factors.

The statistical analysis clearly showed that the die spacer was a key variation factor for reduction of marginal discrepancy of the 4 evaluated factors i.e. with die spacer, with metal ring and with ring less casting technique and combination of ring less with die spacer investment technique. When we compare the marginal discrepancy of castings between the Group-1 and Group-3, we find with the use of die spacer, the lowest discrepancy values were obtained(106.91µm) as compared to that without die spacer (187.06µm) and results are statistically significant at p<0.01.The results are in accordance with those reported by **N.C. Soriani et al. , Olivera and Saito, Milan et. Al[15] ,Fusayama et. al.[16], Eames et.al.[17], Hembree and cooper[18].**

Eames et al noted that relieving the die , casting are seated more completely because internal stress area are substantially relieved, more space is provided for the cement.

This was an interesting result as die-spacer was only applied to within 0.5 mm of the margin to ensure maximum adaptation in these critical areas. Regarding the evaluated factors, from higher to lower discrepancy, the obtained values can be arranged in the following order:

Metal Ring without Die Spacer > Ring Less without Die Spacer > Metal Ring with Die Spacers > Ring Less with Die Spacers. There was a significant difference between the groups. But there was extremely significant difference between the (Group-4) i.e. Ring Less casting technique with Die Spacers and the other tested groups.

Based on the obtained results, the lowest marginal discrepancy was obtained using ring less casting technique with die spacer (62.42µm) with a significant difference from the marginal discrepancy obtained without die spacer and with the metal ring casting technique only (187.07µm***, 149.86***µm***,106.91***µm i.e. for the Group -1, Group-2 & Group-3).

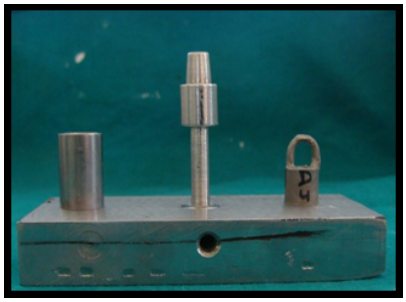
Limitations of the study

Inherited limitations of the casting

Possibility of thickness of die spacer due to operator handling

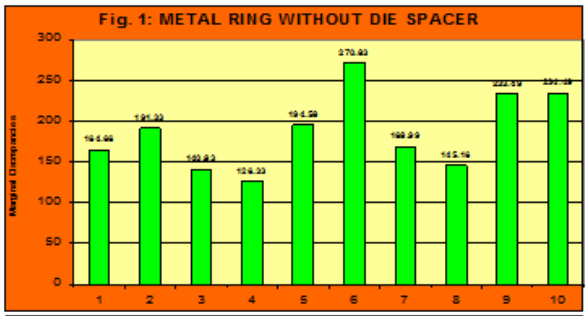
Scope of the study- Further investigation should be conducted to determine its use for fabrication of implant supported prosthesis

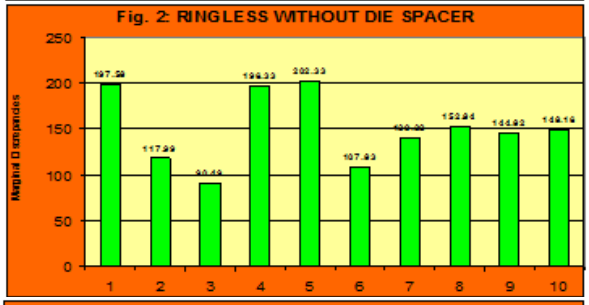
Regarding the superiority of ringless investment technique with die spacer in relation to other variables, lower discrepancy levels for this variable should undergo further studies that might broaden the knowledge of the details involved in the casting process by the lost wax technique

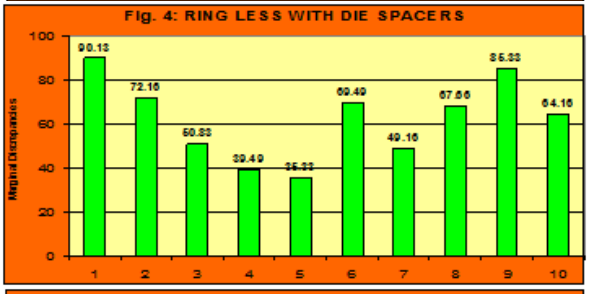


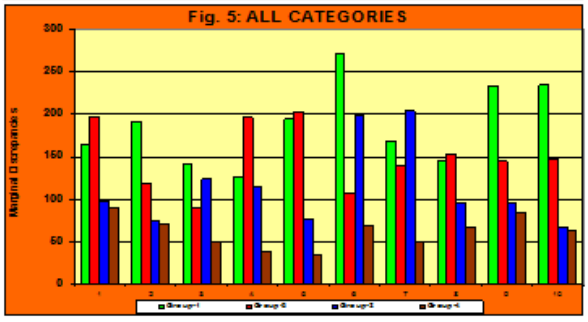
Standard Metal sleeve, S.S. Die, and full cast crown

Wax pattern sprued in Removable Plastic mould(Ringless)









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