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Comparison of Dimensional Accuracy and Bond Strength of Combined Reversible – Irreversible Hydrocolloid Impression System with the Other Commonly Used Impression Materials – An In Vitro Study

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Abstract

A dimensionally accurate impression is one of the primary determinants for a precise fitting indirect restoration. There are some factors that affect definitive impression quality such as tooth preparation design, soft tissue management, tray selection, impression material and impression technique.4,5 There are several elastic impression materials available for dental use: synthetic elastomeric materials, including polysulfide, condensation silicone, addition silicone and polyether; and hydrocolloids.6,7 All these materials are used for reproducing oral conditions in order to construct restorations.In the present in-vitro study an attempt to evaluate and compare the dimensional accuracy of the present day available agar syringeable products combined with alginates to that of the other impression materials which are used commonly in the dental clinics is done .Results showed that the tensile strength of the cartriloids with the conventional alginates available is low and not within the clinical limits of the specifically formulated alginate for the laminate technique, dimensional accuracy of the casts produced from all the agar alginate combinations when compared with that of the Addition Silicone was clinically insignificant.

Introduction

A dimensionally accurate impression is one of the primary determinants for a precise fitting indirect restoration. The clinical success of the indirect restoration requires a precise working model and thus depends upon the

accuracy of the final impression. If a cast restoration is to fit precisely, the die on to which it is to be made must be an exact reproduction of the prepared tooth. Hence, an accurate undistorted impression of the prepared tooth must be ensured.

Impression taking and pouring are critical steps in the process of producing successful crowns and bridges in oral rehabilitation. Impression materials should reproduce hard and soft tissues around prepared and adjacent teeth in order to obtain biologically, mechanically, functionally and esthetically acceptable restorations.1,2,3 There are some factors that affect definitive impression quality such as tooth preparation design, soft tissue management, tray selection, impression material and impression technique.4,5 There are several elastic impression materials available for dental use: synthetic elastomeric materials, including polysulfide, condensation silicone, addition silicone and polyether; and hydrocolloids.6,7 All these materials are used for reproducing oral conditions in order to construct restorations. One example of hydrocolloid is alginate, a popular material in the last years because of its easy mixing and low cost when compared to elastomers. Although some professionals have been using alginate in clinical practice for definitive impressions, problems with dimensional stability and unsatisfactory detail reproduction are some of the limitations to its use.8Over time; several materials have been introduced in the marketplace in order to improve impression quality. The first synthetic elastomeric impression material, launched in 1950, was polysulfide. Its elasticity was sufficient for it to be removed from retentive areas. Later, in 1955, the introduction of condensation silicone represented an advance in impressions materials, as it no longer required custom trays. In 1965, polyether was introduced in Germany as the first elastomeric material developed to be used in dentistry, while the others were first used in industry. Addition silicones were launched in 1975 presenting good characteristics.6, 7 In spite of their different characteristics; all these impression materials are used for reproducing oral tissues.

Distortion of an impression is not caused by the material alone. It results from many other factors such as the space between tray and tooth preparation, impression technique, storage conditions, relaxation of stresses caused by the use of a non rigid tray, excessive seating pressure, too slow removal from the mouth or an impression removed before the polymerization is completed.8The results of investigations into polyvinyl siloxane impression materials indicate that they produce highly accurate impressions because they reproduce fine surface detail, and have excellent elastic recovery, adequate tear strengths, and exceptional dimensional stability. They are compatible with all common die materials, can be disinfected or sterilized, and can be repoured after delayed periods. They are dispensed in convenient automixing dual cartridges or single tubes and are available in several viscosities. If handled appropriately, polyvinylsiloxanes can be applied in almost any indirect procedure. Reversible hydrocolloid produces casts of excellent dimensional accuracy and acceptable surface detail, if poured immediately. Reversible hydrocolloid's lack of dimensional stability is due primarily to the ease with which water can be released from or absorbed by the material (syneresis and imbibition). The accuracy of a reversible hydrocolloid impression is improved if the material has as much bulk as possible (low surface area/volume ratio). Reversible hydrocolloid's lack of dimensional stability is due primarily to the ease with which water can be released from or absorbed by the material (syneresis and imbibition). The accuracy of a

reversible hydrocolloid impression is improved if the material has as much bulk as possible (low surface area/volume ratio). Hence, a custom impression tray is not required. But the disadvantages of reversible hydrocolloid are it has low tear resistance, low stability, cumbersome equipment and high cost.

Irreversible hydrocolloid has the advantages of rapid set, straight forward technique, low cost and less armamentarium. But the disadvantages are poor accuracy, surface detail and low stability, hence needs to be poured immediately. A modification to the agar impression is the combined agar alginate technique (laminate technique). The hydrocolloid in the tray is replaced with a mix of alginate which bonds with the agar expressed from a syringe. The alginate gels by a chemical reaction whereas the agar gels by means of contact with the chilled alginate.9 Since, the agar and not the alginate will be in contact with the prepared teeth, maximum detail is reproduced. When agar is used individually as an impression material, the pre impression procedure is time consuming. It requires constant monitoring of the water level of hot water bath, the time and temperature, etc. But in the laminate technique, these disadvantages are eliminated making the procedure user friendly; as only the syringe material needs to be heated, equipment cost is lower and less preparation time is required.10Studies have been done earlier in the literature to compare the accuracy of this technique in the 1980s. Because of the advancement in the elastomeric materials; agar is very rarely available in India as an impression material and is used only as a duplicating medium in the laboratories. Hence, this in vitro study is an attempt to evaluate and compare the dimensional accuracy of the present day available agar syringeable products combined with alginates to that of the other impression materials which are used commonly in the dental clinics.

Methodology

Two commercially available agar syringeable products [Green cartriloids (identic syringeable agar) and White cartriloids] (fig-1 & 2)

Fig. 1: Identic Syringeable Reversible Hydrocolloid Material

Fig .2 : White Cartiloids Reversible Hydrocolloid Material

And three commercially available alginates (Identic, Zelgan and tropicalgin) were mixed in various combinations.(fig 3,4 and 5).

Fig. 3: Identic irreversible hydrocolloid

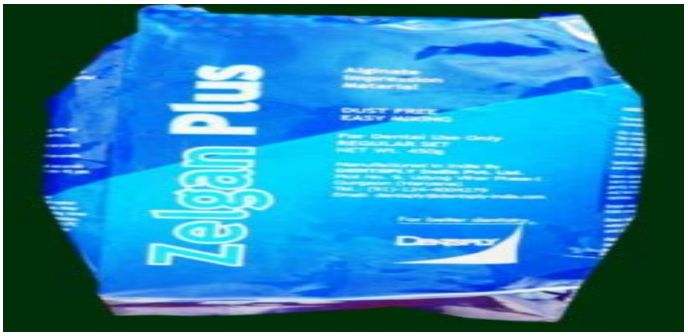


Fig. 4: Zelgan irreversible hydrocolloid

Fig. 5: Tropicalgin irreversible hydrocolloid .

6 groups of agar alginate combinations were made.

GROUP I: WHITE CARTRILOIDS + ZELGAN

GROUP II: GREEN CARTRILOIDS + ZELGAN

GROUP III: WHITE CARTRILOIDS + IDENTIC ALGINATE

GROUP IV: GREEN CARTRILOIDS + IDENTIC ALGINATE

GROUP V: WHITE CARTRILOIDS + TROPICALGIN

GROUP VI: GREEN CARTRILOIDS + TROPICALGIN

Procedure

To Compare The Dimensional Accuracy:

A typhodont jaw set was arranged with all the maxillary teeth in place except 26. Then 16 was prepared for full veneer metal crown and 25 and 27 was prepared for 3 unit full veneer fixed partial denture. Then an impression was made of the maxillary arch with Addition silicone using putty wash technique.

The impression was poured with die stone and then an identical metal model was fabricated.(fig-6)

Fig. 6.metal model to evaluate dimensional accuracy.

As custom trays are more reliable for impression making with addition silicone37, a custom tray was fabricated on the metal model for impression making with addition silicone. The spacer used was 4 mm in thickness i.e. 2 sheets of modeling wax. The 4mm space was decided as regular body addition silicone requires minimum of 4 mm thickness for impression.38 3 orientation stops were designed (one in the centre of palate and 2 in the posterior region).(fig-7)

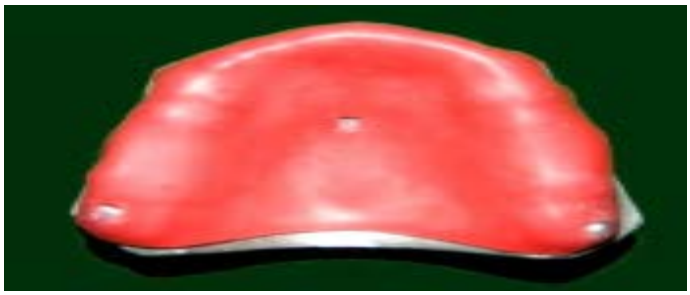


Fig. 7: wax sheet adapted over metal model.

Above the 2 layers of modeling wax, a layer of tin foil was adapted which melted from the polymerization heat of the material to prevent it from contaminating the inside of the tray.(fig-8)

Fig. 8: tin foil adapted over wax sheet

Then a custom tray was fabricated with autopolymerzing acrylic resin.(fig-9)

Fig-9. special tray fabricated for additional silicone.

A stock tray of appropriate size was selected for impression making with agar alginate combination. This stock tray was then customized using autopolymerizing acrylic resin i.e. orientation stops (one in the anterior region and 2 in the posterior region and one large stop in the posterior border) so that the tray fits in one position for every impression. The stops were made 5mm in height as 5 mm is the minimum thickness required for a hydrocolloid impression.(fig-10)

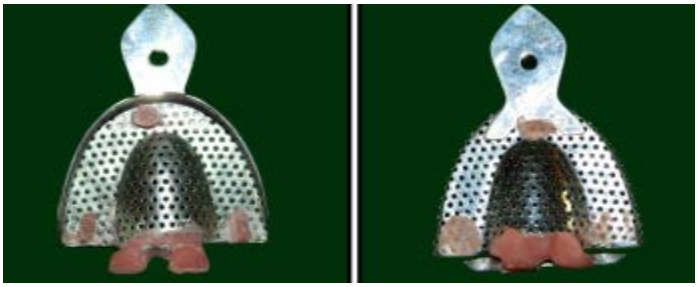


Fig. 10:Tray for agar alginate combination impressions. Sample size decided for each group was 6.

6 impressions were made of the customized metal model with the designed stock tray.(fig-11)

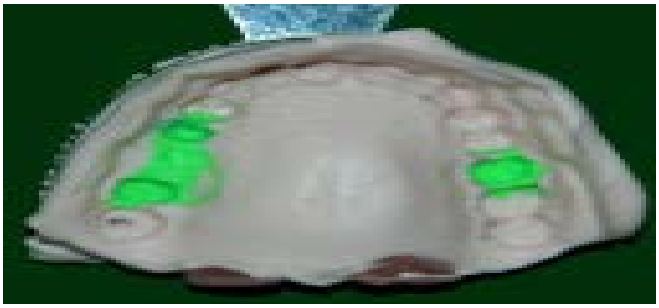


Fig.11a : Green **Cartriloid+ Identic Alginate Impression**

Fig.11b: **White Cartriloid + Identic Alginate Impression**

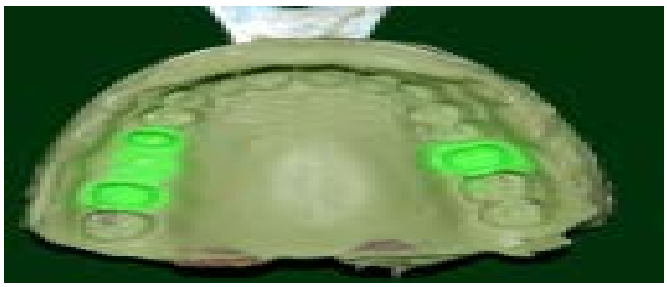


Fig-11c : **Green Cartriloid + Zelgan Alginate Impression**

Fig-11d: White **Cartriloid + Zelgan Alginate Impression**

Fig. 11e: Green **Cartriloid + Tropicalgin Impression**

Fig. 11f: White **Cartriloid + Tropicalgin Impression**

Then 6 impressions were made with addition silicone (regular body) with the special tray fabricated for using addition silicone. All the impressions made with the agar alginate combinations were poured immediately with improved stone i.e. Type IV Gypsum product. The impressions made with addition silicone were poured with the same material but after half an hr to minimize the air bubble formation in the cast due to the release of hydrogen gas from the addition silicone. Improved stone was mixed in the vacuum mixing flask with the water powder ratio 0.18-0.22. Each cast was marked with the reference points i.e. centre of all the prepared teeth.

Point A: centre of prepared 16.

Point B: centre of prepared 25.

Point C: centre of prepared 27.

Distances AB, BC and AC was measured using travelling microscope. (fig-12)

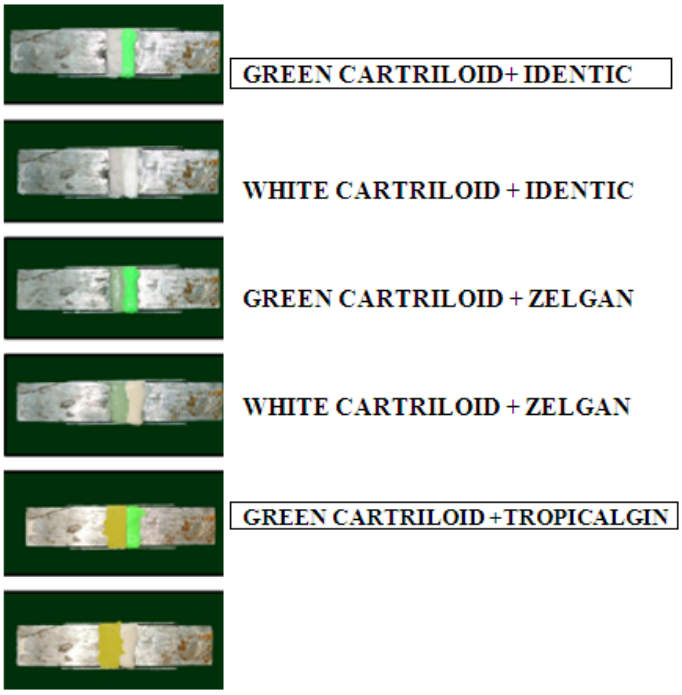
Fig-12. **Measurements Recorded By Travelling Microscope**

Also, the buccolingual, mesiodistal diameter and height of the prepared teeth were measured with travelling microscope.

Then all these measurements were compared to that of the casts prepared from the addition silicone. All the measurements were subjected to statistical analysis.

To Check the Tensile Bond Strength

A metal model was customized in which 2 metal blocks could slide in and stop at a desired point.(fig-13).



White Cartriloid+ Tropicalgin

Fig -13.Materials Loaded For Testing Tensile Bond Strength

The point separated the blocks in such a way that the two blocks were 6mm apart. Also the height of the blocks was 6mm as 6mm is the minimum thickness that is required to make a hydrocolloid impression. Holes were drilled in the metal blocks at the border for retention of agar and alginate. The two metal blocks were placed on the model and were moved till they stopped at a predetermined position. Then one block was loaded with agar and other

with the alginate. After the materials set, the metal blocks were pulled apart on the Instron tensile bond strength machine (fig-14) to check the load at which the bond breaks between agar and alginate.

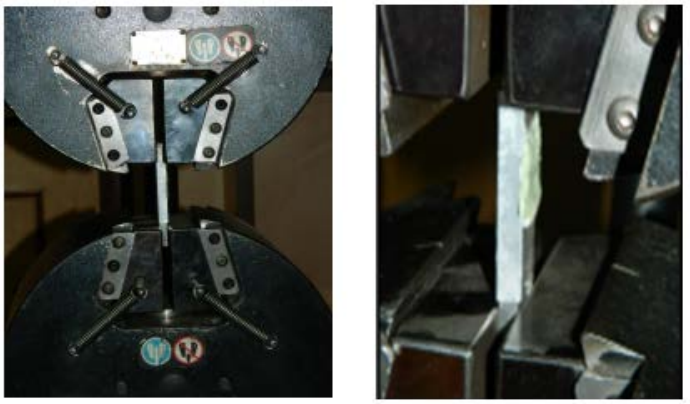


Fig -14.Tensile Bond Strength Recorded On Instron Testing Machine

Thus, the reading for the tensile bond strength between the agar alginate combinations was recorded. 6 readings were recorded for each group and the values were compared and statistically analyzed.

Results

In this study, 2 parameters were considered i.e. dimensional accuracy of the agar alginate combinations with the addition silicone and the tensile bond strength between

the agar alginate combinations. Agar Alginate combinations were as follows:

GROUP I: WHITE CARTRILOIDS + ZELGAN

GROUP II: GREEN CARTRILOIDS + ZELGAN

GROUP III: WHITE CARTRILOIDS + IDENTIC ALGINATE

GROUP IV: GREEN CARTRILOIDS + IDENTIC ALGINATE

GROUP V: WHITE CARTRILOIDS + TROPICALGIN

GROUP VI: GREEN CARTRILOIDS + TROPICALGIN

Table I shows the readings for the measurements done on the casts produced from addition silicone impressions.

TABLE I

ADDITION SILICONE

S.No.	AB (cm)	BC (cm)	AC (cm)	16			25			27		
				MD (mm)	BL (mm)	H (mm)	MD (mm)	BL (mm)	H (mm)	MD (mm)	BL (mm)	H (mm)
1	4.685	1.87	5.410	6.712	8.574	6.904	3.671	6.157	6.591	7.109	8.127	7.240
2	5.005	1.96	5.27	6.698	8.570	6.850	3.597	6.005	6.664	6.996	8.225	7.016
3	4.875	1.715	5.385	6.551	8.625	6.865	3.674	6.127	6.604	6.987	8.216	7.072
4	4.96	2.005	5.44	6.556	8.617	6.915	3.609	6.257	6.581	7.021	8.187	7.245
5	5.115	2.105	5.435	6.541	8.591	6.878	3.568	6.116	6.490	7.124	8.197	7.172
6	5.015	1.955	5.215	6.717	8.587	6.842	3.575	6.247	6.575	7.121	8.214	7.147

Tables II and III: Compares the same readings with that of the metal model and conclude that All t-values are < 2.228 for p=0.05 shows no significant difference between addition silicone and metal model. Literature review for accuracy of addition silicone is confirmed and hence, accuracy of agar alginate combinations can be compared with addition silicone as standard.

TABLE II

MEAN AND STANDARD DEVIATION FOR ADDITION SILICONE AND METAL MODEL. ALSO COMPARSION BETWEEM THEM BY STUDENT'S T - VALUE

	AB		BC		AC	
	ADDITION SILICONE	METAL MODEL	ADDITION SILICONE	METAL MODEL	ADDITION SILICONE	METAL MODEL
MEAN	4.9425	4.9825	1.935	1.8985	5.3592	5.3937
STANDARD DEVIATION	0.1254	0.1622	0.1118	0.1384	0.0795	0.1079
T-VALUE	0.44		0.46		0.58	

TABLE III

MEAN AND STANDARD DEVIATION FOR ADDITION SILICONE AND METAL MODEL. ALSO COMPARSION BETWEEM THEM BY STUDENT'S T - VALUE

		16			25			27		
		MD	BL	H	MD	BL	H	MD	BL	H
METAL MODEL	MEAN	6.654	8.593	6.876	3.594	6.140	6.612	7.061	8.198	7.162
	SD	0.07	0.02	0.03	0.03	0.07	0.05	0.06	0.008	0.08
ADDITION SILICONE	MEAN	6.29	8.594	6.875	3.616	6.152	6.584	7.059	8.194	7.149
	SD	0.08	0.02	0.03	0.04	0.09	0.05	0.06	0.03	0.08
T-VALUE		0.53	0.12	0.03	0.86	0.22	0.90	0.03	0.29	0.26

Conclusion from Tables II AND III: All t-values are < 2.228 for p=0.05 shows no significant difference between addition silicone and metal model. Literature review for accuracy of addition silicone is confirmed and hence, accuracy of agar alginate can be compared with addition silicone as standard.

Tables IV, V, VI, VII, VIII and IX show the readings for the measurements done on the casts produced by the six groups of agar alginate combinations.

TABLE IV

GROUP I: WHITE CARTRILOIDS + ZELGAN

S.No.	AB (cm)	BC (cm)	AC (cm)	16			25			27		
				MD (mm)	BL (mm)	H (mm)	MD (mm)	BL (mm)	H (mm)	MD (mm)	BL (mm)	H (mm)
1	4.78	1.96	5.432	6.571	8.561	6.875	3.642	6.115	6.575	7.105	8.215	7.125
2	5.15	1.875	5.410	6.595	8.575	6.890	3.665	6.210	6.580	7.015	8.255	7.250
3	4.565	1.715	5.385	6.610	8.591	6.915	3.631	6.305	6.475	6.985	8.195	7.155
4	4.410	2.105	5.370	6.495	8.545	6.845	3.670	6.005	6.490	6.970	8.285	7.145
5	5.055	2.005	5.515	6.550	8.595	6.850	3.645	6.125	6.525	7.125	8.250	7.010
6	4.985	1.955	5.445	6.565	8.571	6.870	3.631	6.250	6.590	7.120	8.195	7.241

TABLE V

GROUP II: GREEN CARTRILOIDS + ZELGAN

S.No.	AB (cm)	BC (cm)	AC (cm)	16			25			27		
				MD (mm)	BL (mm)	H (mm)	MD (mm)	BL (mm)	H (mm)	MD (mm)	BL (mm)	H (mm)
1	4.415	2.105	5.40	6.605	8.605	6.865	3.605	6.105	6.587	7.124	8.205	7.240
2	5.015	1.870	5.215	6.712	8.584	6.854	3.670	6.197	6.612	7.027	8.287	7.147
3	4.875	1.960	5.860	6.505	8.571	6.905	3.644	6.242	6.590	6.972	8.185	7.015
4	4.810	1.565	4.950	6.581	8.555	6.885	3.642	6.225	6.497	6.961	8.215	7.172
5	5.205	2.350	5.270	6.610	8.591	6.875	3.671	6.115	6.525	7.147	8.220	7.165
6	5.150	1.670	5.055	6.595	8.585	6.870	3.591	6.240	6.672	7.161	8.205	7.245

TABLE VI

GROUP III: WHITE CARTRILOIDS + IDENTIC ALGINATE

S.No.	AB (cm)	BC (cm)	AC (cm)	16			25			27		
				MD (mm)	BL (mm)	H (mm)	MD (mm)	BL (mm)	H (mm)	MD (mm)	BL (mm)	H (mm)
1	5.125	1.710	5.87	6.702	8.615	6.872	3.572	6.105	6.584	7.107	8.205	7.124
2	5.210	2.115	4.965	6.550	8.580	6.847	3.584	6.215	6.497	6.997	8.301	7.251
3	4.86	1.975	5.432	6.490	8.575	6.891	3.547	6.350	6.614	7.027	8.197	7.191
4	4.785	1.96	5.385	6.507	8.563	6.885	3.606	6.010	6.602	7.015	8.191	7.030
5	4.61	1.875	5.42	6.665	8.570	6.905	3.581	6.255	6.671	7.156	8.255	7.246
6	4.825	1.61	5.895	6.695	8.561	6.912	3.592	6.240	6.587	6.965	8.216	7.172

TABLE VII

GROUP IV: GREEN CARTRILOIDS (IDENTIC) + IDENTIC ALGINATE

S.No.	AB (cm)	BC (cm)	AC (cm)	16			25			27		
				MD (mm)	BL (mm)	H (mm)	MD (mm)	BL (mm)	H (mm)	MD (mm)	BL (mm)	H (mm)
1	5.215	2.105	5.385	6.550	8.561	6.917	3.644	6.242	6.591	7.027	8.217	7.128
2	5.005	1.87	5.43	6.595	8.605	6.857	3.640	6.357	6.497	7.015	8.198	7.145
3	4.835	1.965	4.95	6.712	8.575	6.864	3.671	6.117	6.603	7.167	8.167	7.010
4	4.425	1.582	5.27	6.581	8.612	6.809	3.684	6.215	6.525	7.156	8.201	7.124
5	5.025	1.675	4.965	6.570	8.593	6.912	3.592	6.254	6.671	7.058	8.255	7.252
6	4.86	1.875	5.410	6.605	8.570	6.891	3.597	6.351	6.674	7.161	8.295	7.190

TABLE VIII

GROUP V: WHITE CARTRILOIDS + TROPICALGIN

S.No.	AB (cm)	BC (cm)	AC (cm)	16			25			27		
				MD (mm)	BL (mm)	H (mm)	MD (mm)	BL (mm)	H (mm)	MD (mm)	BL (mm)	H (mm)
1	5.210	1.915	5.565	6.701	8.617	6.903	3.670	6.171	6.591	6.989	8.185	7.240
2	4.86	2.015	5.48	6.505	8.585	6.878	3.644	6.127	6.614	6.996	8.220	7.212
3	4.785	1.720	5.435	6.610	8.570	6.861	3.671	6.247	6.681	7.014	8.220	7.154
4	5.055	1.865	5.335	6.597	8.591	6.854	3.592	6.251	6.597	7.012	8.216	7.127
5	4.97	1.925	5.215	6.617	8.587	6.805	3.514	6.205	6.591	7.015	8.185	7.197
6	5.15	1.795	5.21	6.659	8.625	6.851	3.509	6.215	6.511	6.998	8.213	7.105

TABLE IX

GROUP VI: GREEN CARTRILOIDS + TROPICALGIN

S.No.	AB (cm)	BC (cm)	AC (cm)	16			25			27		
				MD (mm)	BL (mm)	H (mm)	MD (mm)	BL (mm)	H (mm)	MD (mm)	BL (mm)	H (mm)
1	5.125	1.875	5.427	6.702	8.574	6.875	3.642	6.114	6.571	7.105	8.215	7.145
2	4.785	2.005	5.439	6.697	8.561	6.842	3.609	6.121	6.509	6.981	8.197	7.017
3	4.610	1.865	5.55	6.595	8.612	6.914	3.661	6.005	6.614	6.995	8.225	7.156
4	5.055	1.913	5.47	6.587	8.605	6.857	3.671	6.125	6.604	7.027	8.207	7.187
5	5.15	1.710	5.125	6.714	8.615	6.881	3.680	6.250	6.591	7.111	8.235	7.121
6	4.96	1.715	5.210	6.702	8.618	6.902	3.661	6.104	6.581	7.121	8.195	7.097

Table X shows the mean and standard deviation for the all groups of agar alginate combinations for the distance AB, BC and AC.

TABLE X

MEAN AND STANDARD DEVIATION FOR THE ALL GROUPS OF AGAR ALGINATE COMBINATIONS

GROUP	DISTANCE	MEAN	STANDARD DEVIATION
WHITE CART + ZELGAN	AB	4.8242	0.2467
	BC	1.9358	0.1114
	AC	5.4262	0.0437
GREEN CART + ZELGAN	AB	4.9117	0.2426
	BC	1.92	0.2425
	AC	5.3083	0.3014
WHITE CART + IDENTIC ALGINATE	AB	4.9025	0.1894
	BC	1.8742	0.1569
	AC	5.3612	0.2661
GREEN CART + IDENTIC ALGINATE	AB	4.8942	0.2254
	BC	1.8452	0.1609
	AC	5.235	0.1877
WHITE CART + TROPICALGIN	AB	5.005	0.1395
	BC	1.8725	0.0879
	AC	5.3733	0.1226
GREEN CART + TROPICALGIN	AB	4.9475	0.1791
	BC	1.8472	0.0976
	AC	5.3702	0.1394

Table XI shows the student's t - value to compare distance AB, BC, AC of six groups with standard group and concludes that there is no significant difference between standard group (Addition silicone) and six groups for AB, BC, and AC distances.

TABLE XI

STUDENT'S T - VALUE TO COMPARE DISTANCE AB, BC, AC OF SIX GROUPS WITH STANDARD GROUP

GROUP	DISTANCE	T - VALUE
WHITE CART + ZELGAN	AB	0.96
	BC	0.01
	AC	1.65
GREEN CART + ZELGAN	AB	0.25
	BC	0.13
	AC	0.36
WHITE CART + IDENTIC ALGINATE	AB	0.39
	BC	0.71
	AC	0.02
GREEN CART + IDENTIC ALGINATE	AB	0.42
	BC	1.03
	AC	1.36
WHITE CART + TROPICALGIN	AB	0.75
	BC	0.98
	AC	0.21
GREEN CART + TROPICALGIN	AB	0.05
	BC	1.33
	AC	0.15

Conclusion

All t-values are < 2.228 for p=0.05 shows no significant difference between standard group and six groups for AB, BC and AC distance.

TABLE XII Shows the mean and standard deviation for six groups of agar alginate combinations for the mesiodistal diameter (MD), buccolingual diameter (BL) and height (H) of the prepared teeth.

TABLE XII

MEAN AND STANDARD DEVIATION FOR SIX GROUPS

		16			25			27		
		MD	BL	H	MD	BL	H	MD	BL	H
WHITE CART + ZELGAN	MEAN	6.564	8.573	6.874	3.647	6.168	6.539	7.053	8.234	7.154
	SD	0.04	0.02	0.02	0.02	0.09	0.05	0.06	0.07	0.08
GREEN CART + ZELGAN	MEAN	6.601	8.579	6.876	3.637	6.187	6.535	7.065	8.219	7.164
	SD	0.06	0.02	0.02	0.03	0.05	0.14	0.08	0.03	0.08
WHITE CART + IDENTIC ALGINATE	MEAN	6.602	8.577	6.885	3.584	6.196	6.593	7.045	8.228	7.169
	SD	0.09	0.01	0.02	0.02	0.11	0.05	0.07	0.04	0.08
GREEN CART + IDENTIC ALGINATE	MEAN	6.602	8.586	6.875	3.638	6.256	6.594	7.097	8.222	7.137
	SD	0.05	0.02	0.04	0.03	0.08	0.07	0.07	0.04	0.07
WHITE CART + TROPICALGIN	MEAN	6.615	8.596	6.859	3.6	6.203	6.598	7.004	8.207	7.173
	SD	0.06	0.02	0.03	0.08	0.04	0.05	0.01	0.02	0.05
GREEN CART + TROPICALGIN	MEAN	6.666	8.598	6.879	3.654	6.119	6.578	7.057	8.212	7.121
	SD	0.05	0.02	0.02	0.02	0.07	0.03	0.06	0.01	0.05

Table XIII shows the student's t - value to compare distance MD, BL and H values of six groups with standard group and concludes that there

is no significant difference between standard group (Addition silicone) and six groups for MD, BL and H values.

TABLE XIII

STUDENT'S T - VALUE TO COMPARE SIX GROUPS WITH STANDARD GROUP(ADDITION SILICONE)

	16			25			27		
	MD	BL	H	MD	BL	H	MD	BL	H
WHITE CART + ZELGAN	1.64	1.76	0.09	1.57	0.29	1.47	0.16	1.11	0.10
GREEN CART + ZELGAN	0.62	1.35	0	0.92	0.78	0.75	0.13	1.23	0.29
WHITE CART + IDENTIC ALGINATE	0.52	1.36	0.63	1.43	0.71	0.26	0.38	1.46	0.39
GREEN CART + IDENTIC ALGINATE	0.63	0.65	0.03	0.92	1.97	0.25	0.95	1.17	0.25
WHITE CART + TROPICALGIN	0.32	0.15	0.95	0.44	1.19	0.42	2.07	0.75	0.55
GREEN CART + TROPICALGIN	0.86	0.26	0.17	2.13	0.64	0.21	0.08	1.13	0.64

Conclusion

ALL T-VALUES ARE < 2.228 FOR P=0.05 SHOWS NO Significant Difference between Standard Group and Six Groups.

Table XIV shows the values obtained for the tensile bond strength for all the 6 groups on the Instron testing machine.

TABLE XIV

TENSILE BOND STRENGTH BETWEEN AGAR AND ALGINATE

AGAR ALGINATE COMBINATION	1 (N)	2 (N)	3 (N)	4 (N)	5 (N)	6 (N)
WHITE CART + ZELGAN	4.81	4.76	4.87	4.93	4.89	4.97
GREEN CART + ZELGAN	5.02	5.13	5.15	5.27	5.23	5.21
WHITE CART + IDENTIC ALGINATE	4.21	4.16	4.24	4.28	4.24	4.30
GREEN CART + IDENTIC ALGINATE	5.97	6.12	6.04	6.01	6.07	5.98
WHITE CART + TROPICALGIN	3.25	3.28	3.21	3.31	3.19	3.32
GREEN CART + TROPICALGIN	5.09	5.04	5.11	5.20	5.24	5.16

AS GROUP IV i.e. GREEN CARTRILOIDS (IDENTIC) + IDENTIC ALGINATE has the highest bond strength and it is the formulated combination for the laminate impression technique, it is taken as standard to compare the bond strength for the rest of the groups.

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TABLE XV shows the student's t - value to compare six groups with standard group (green cart + identic alginate) and concludes that all t-values are > 2.228 for p=0.05 shows significant difference between standard group and other groups. Hence, the best agar alginate combination to be used is Identic (green) cartriloids + Identic alginate i.e. Group IV.

TABLE XV

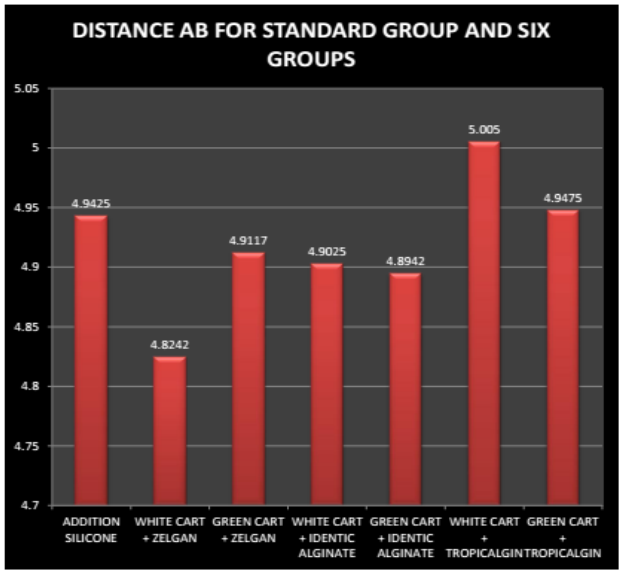
STUDENT'S T - VALUE TO COMPARE SIX GROUPS WITH STANDARD GROUP

(GREEN CART + IDENTIC ALGINATE)

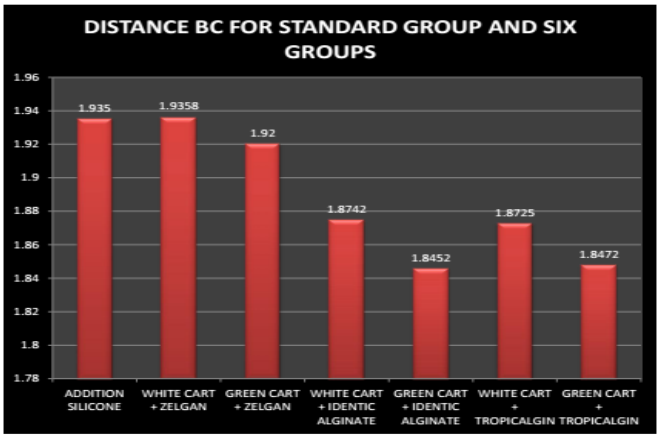
	GREEN CART + IDENTIC ALGINATE (GROUP IV)	WHITE CART + ZELGAN (GROUP I)	GREEN CART + ZELGAN (GROUP II)	WHITE CART + IDENTIC ALGINATE (GROUP III)	GREEN CART + TROPICALGIN (GROUP V)	WHITE CART + TROPICALGIN (GROUP VI)
MEAN	6.032	4.872	5.168	4.238	5.14	3.26
SD	0.05	0.07	0.08	0.05	0.07	0.05
T VALUE		29.63	19.99	57.91	23.37	87.24

Conclusion: All T-Values Are > 2.228 For P=0.05 Shows Significant Difference Between Standard Group And Other Groups.

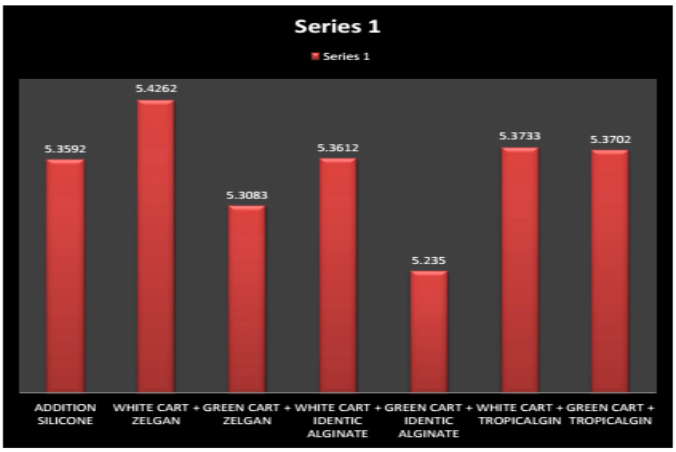
GRAPH I



GRAPH II

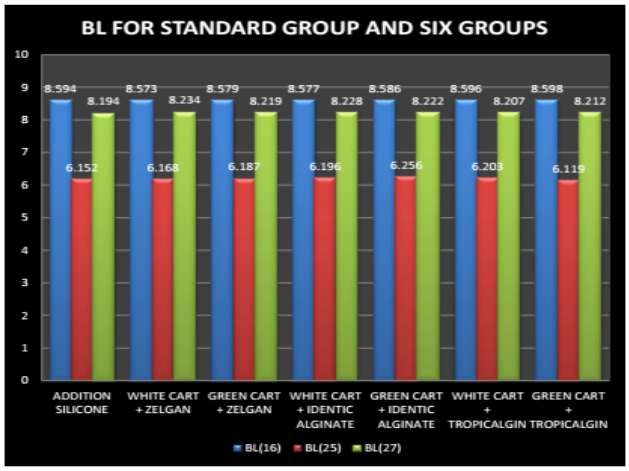


GRAPH III

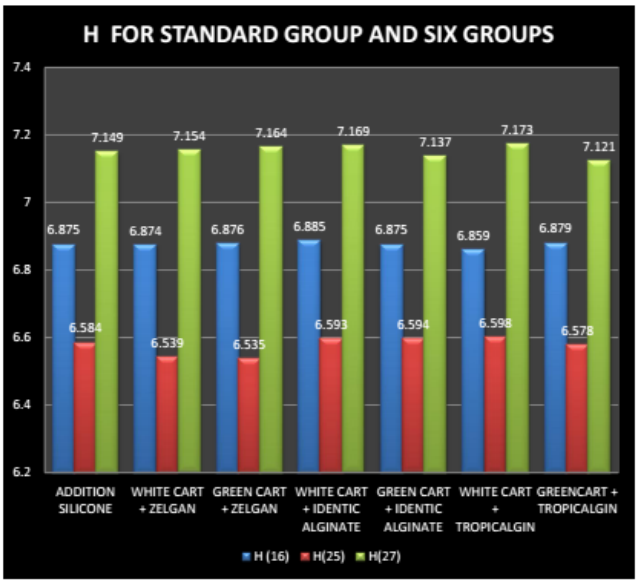


GRAPH IV

GRAPH V



GRAPH VI



Discussion

A dimensionally accurate impression is one of the primary determinants for a precise fitting indirect restoration. The clinical success of the indirect restoration requires a precise working model and thus depends upon the accuracy of the final impression.14 Impression taking and pouring are critical steps in the process of producing successful crowns and bridges in oral rehabilitation. Impression materials should reproduce hard and soft tissues around prepared and adjacent teeth in order to obtain biologically, mechanically, functionally and esthetically acceptable restorations.15, 16 there are some factors that affect definitive impression quality such as tooth preparation design, soft tissue management, tray selection, impression material and impression technique.17, 18 Reversible hydrocolloid produces casts of excellent dimensional accuracy and acceptable surface detail, if poured immediately. Reversible hydrocolloid's lack of dimensional stability is due primarily to the ease with which water can be released from or absorbed by the material (syneresis and imbibition). The accuracy of a reversible hydrocolloid impression is improved if the material has as much bulk as possible (low surface area/volume ratio). Reversible hydrocolloid's lack of dimensional stability is due primarily to the ease with which water can be released from or absorbed by the material (syneresis and imbibition). The accuracy of a reversible hydrocolloid impression is improved if the material has as much bulk as possible (low surface area/volume ratio). Hence, a custom impression tray is not required. But the disadvantages of reversible hydrocolloid are it has low tear resistance, low stability, cumbersome equipment and high cost.19,20,21 Irreversible hydrocolloid has the advantages of rapid set, straight forward technique, low cost and less armamentarium. But the disadvantages are poor accuracy, surface detail and low stability, hence needs to be poured immediately. 19-25 Carl H.J outlined the techniques to avoid the inaccuracies during the use of alginate impression material.

1) Alginate mix should have smooth creamy consistency.
2) Precooling the instruments and use of cool water.
3) Impression should be removed with sudden snap about 2-3 min after the time of set.
4) Impression should pour instantly and removed after the pouring.24

Andrew et al conducted study on the accuracy of new alginates and traditional alginates according to them new alginates are 2-3 times costly than the alginate. But their study does not indicate that increased price correspond to that of the similar increased in success of impression.25 A modification to the traditional agar procedure is the combined agar alginate technique. The hydrocolloid in the tray is replaced with a mix of chilled alginate that bonds with the agar expressed from a syringe. The alginate gels by a chemical reaction, whereas the agar gels by means of contact with the cool alginate rather than with the water circulating through the tray. Since, the agar and not the

alginate will be in contact with the prepared teeth, maximum detail is reproduced. When agar is used individually as an impression material, the pre impression procedure is time consuming. It requires constant monitoring of the water level of hot water bath, the time and temperature, etc. But in the laminate technique, these disadvantages are eliminated making the procedure user friendly; as only the syringe material needs to be heated, equipment cost is lower and less preparation time is required.15 The results of investigations into polyvinyl siloxane impression materials indicate that they produce highly accurate impressions because they reproduce fine surface detail, and have excellent elastic recovery, adequate tear strengths, and exceptional dimensional stability. They are compatible with all common die materials, can be disinfected or sterilized, and can be repoured after delayed periods. They are dispensed in convenient automixing dual cartridges or single tubes and are available in several viscosities. If handled appropriately, polyvinyl siloxanes can be applied in almost any indirect procedure.19, 20, 26-32 In the present study, two commercially available agar syringeable products [Green cartriloids (identic syringeable agar) and White cartriloids] and three commercially available alginates (Identic, Zelgan and tropicalgin) were mixed in various combinations. 6 groups of agar alginate combinations were made.

GROUP I: WHITE CARTRILOIDS + ZELGAN

GROUP II: GREEN CARTRILOIDS + ZELGAN

GROUP III: WHITE CARTRILOIDS + IDENTIC ALGINATE

GROUP IV: GREEN CARTRILOIDS + IDENTIC ALGINATE

GROUP V: WHITE CARTRILOIDS + TROPICALGIN

GROUP VI: GREEN CARTRILOIDS + TROPICALGIN.

Tables II and III compare the readings of the addition silicone with that of the metal model and conclude that all t-values are < 2.228 for p=0.05 shows no significant difference between addition silicone and metal model. Literature review for accuracy of addition silicone was confirmed and hence, accuracy of agar alginate combinations was compared with addition silicone as standard. Table XI shows the student's t - value to compare distance AB, BC, AC of six groups with standard group and concludes that there is no significant difference between standard group (Addition silicone) and six groups for AB, BC, and AC distances. Table XIII shows the student's t - value to compare distance MD, BL and H values of six groups with standard group and concludes that there is no significant difference between standard group (Addition silicone) and six groups for MD, BL and H values.

Table XIV shows the values obtained for the tensile bond strength for all the 6 groups on the Instron testing machine.

AS GROUP IV i.e. GREEN CARTRILOIDS (IDENTIC) + IDENTIC ALGINATE has the highest bond strength and it is the formulated combination for the laminate impression technique, it was taken as standard to compare the bond strength for the rest of the groups. TABLE XV shows the student's t - value to compare six groups with standard group (green cart + identic alginate) and concludes that all t-values are > 2.228 for p=0.05 shows significant difference between standard group and other groups. Hence, the best agar alginate combination to be used is Identic (green) cartriloids + Identic alginate i.e. Group IV. The results of this in vitro study clearly indicate that the dimensional accuracy of the casts produced from all the combinations is the same as that of the addition

silicone. Skinner and Hoblit demonstrated that the dimensional stability of reversible/irreversible hydrocolloid impression material was as accurate as other material used independently. The results showed that the technique employing an impression of both reversible and irreversible hydrocolloid materials in combination can be employed with accuracy equal to that of the other techniques. All of the impressions exhibited distortions after removal, but generally the distortions were considered to be small in comparison to the errors inherent in most other impression techniques. A slight distortion occurred during the 10 minutes during which observations were made subsequent to the removal of the impression. The relation of the impressed areas to their position in the tray is important. In general, a large bulk of impression material between an undercut area and the tray is conducive to a greater accuracy in the impression. 9 Fusayama et al conducted a study to compare the dimensional accuracy of reversible and irreversible hydrocolloids individually and in combination with silicone elastomeric impression materials for indirect inlays. The combined reversible/irreversible hydrocolloid impression system provides no statistically significant difference with other impression system and eliminates the disadvantages of both the materials when used individually. They stated that the laminated hydrocolloid indirect impression technique is simple, accurate, and eliminates the disadvantages of both materials when used individually.10 Herring HW, Tames MA, Zardiackas LD conducted an investigation to compare the difference in dimensional accuracy of a combined reversible-irreversible hydrocolloid impression system and the other commonly used impression systems. No statistically significant differences were found between the measurements of the various materials tested and those of the master model. They mentioned that the laminate technique must be handled extremely quickly because of the rapid gelation time of the syringe material. Working time is at a minimum, which may present problems with multiple preparations that are widely spaced. The injection material must flow freely from syringe to preparation to obtain a good impression. Second, on removal of the die from the impression, the die was frequently stained from the

pigment of the reversible hydrocolloid.11 Appleby DC, Smith W, Lontz JF; Mingledorff EB concluded that there was no statistically significant difference in dimensional stability among the eight agar alginate combined impressions tested.

They were sufficiently accurate for single unit restorations but multiple units remained questionable. There was statistically significant discrepancy in the bond strength among the 8 combined impression systems. They also recommended that the council on dental materials and devices be specific for combined reversible/irreversible hydrocolloid impression materials.12Linke BA, Nicholls JI, Faucher RR conducted a study to compare the distortion analysis of stone casts made from the impression materials used commonly. Reversible hydrocolloid impression material produced significantly less interabutment distortion than the irreversible hydrocolloid. Statistically significant differences exist among the impression materials; however, relative to the impression materials currently being used successfully, the combinations of irreversible hydrocolloid with silicone and modified reversible hydrocolloid with irreversible hydrocolloid were clinically acceptable.13

When compared with addition silicone, the laminate impression technique has a number of advantages: 1. A stock tray can be used, no need to fabricate a custom tray.

2. The combined impression sets faster than other elastic impression materials, and

3. The cost per impression is reduced.

4. The materials used are hydrophilic.

The disadvantages are

1. Rapid gelation of irreversible hydrocolloid, i.e. reduced working time, and hence, difficult to use in multiple preparations.

2. Reduced working time

3.Immediate pouring of casts.

4. Multiple casts cannot be produced from the same impression.

The combination technique, in itself, proved to be easy and practical and overcomes many of the shortcomings inherent to conventional reversible hydrocolloid impression techniques. Strict adherence to laboratory procedures for pouring a cast is as critical as for the conventional technique. The combined material-impression technique allows convenience, without sacrificing the detail obtainable with reversible hydrocolloid in the areas of rest, retention, and guide plane preparation. Well-rehearsed teamwork is required for a successful result, since the reversible hydrocolloid begins to set as soon as it is injected. Thus, the irreversible hydrocolloid must be inserted as soon as the injection phase is complete. The impression must be poured immediately in dental stone to ensure dimensional stability. The technique can be used successfully when the variables of manipulation are used correctly.

Summary and Conclusion

1. Dimensional accuracy of the casts produced from all the agar alginate combinations when compared with that of the Addition Silicone was clinically insignificant.

2. On statistical analysis, the difference in the tensile bond strength between the agar alginate combinations used was clinically significant.

3. The tensile bond strength between the agar alginate in the Group IV i.e. Identic cartriloids + Identic Alginate was the highest.

The above results need to be assessed by conducting further in vivo studies and by assessing the use of these materials by various clinicians i.e. ease of manipulation, working time and by noting the other factors involved. The tensile strength of the cartriloids with the conventional alginates available is low and not within the clinical limits of the specifically formulated alginate for the laminate technique i.e. Identic alginate. The syringeable material needs to be assessed and improved such that it gives comparable bond strength with the conventional alginates as the Identic alginate is 3 times the cost of the conventional alginates. Also, the Identic alginate being costlier is economical when compared with the addition silicone.

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