DISCUS DENTAL

Splash!®
Super Hydrophilic Impression Materials

Clinical Evaluations of Vinyl Polysiloxane Impression Materials

FINAL REPORT

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DISCUS DENTAL™
IMPRESSIONS
800-422-9448

EVALUATION 1 Contact Angles

Materials and Methods

Materials

All impression materials were supplied in their original packaging by Discus Dental. The materials, manufacturers and lot numbers are indicated in the following table.

Material	Manufacturer	Lot Number
Aquasil™ (ADA type I)	DENTSPLY Caulk	9711115
Express™ Lite Body – Regular Set	3M	8LN2H1
Impregum® F	ESPE	A95 –B13
Splash!® Extra Lite Wild Berry	Discus Dental	901965 - 901066
Splash!® Lite Wild Berry	Discus Dental	901055 - 901056

Methods

Contact angle measurements were made using droplets of saturated aqueous gypsum. Pseudo-equilibrium contact angles were read at thirty seconds after contact of the drop with the elastomer surface. Measurements were made with a VCA 200 Video Contact Angle System (Advanced Surface Technology, Inc., Billerica, MA 01821). Six drops were measured for each of five specimens for each material, giving a total of 30 measurements per material. Measurements were begun approximately 60 min from the start of mixing.

Results and Discussions

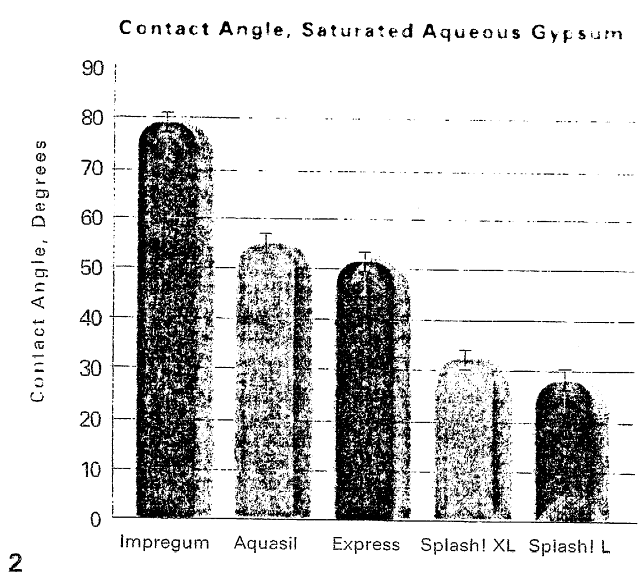
Results

The raw data and statistical analysis are included in the Appendix. The means and standard deviations are:

Material	Contact Angle	Standard Deviation
Aquasil™ (ADA type I)	55.2	1.5
Express™ Lite Body – Regular Set	52.5	1.7
Impregum® F	79.1	1.6
Splash!® Extra Lite Wild Berry	32.2	1.6
Splash!® Lite Wild Berry	28.6	1.6

By SNK, each elastomer constituted a statistical subset. That is, the contact angle of each material was significantly different from those of the other materials at the $p < 0.00001$ level.

The materials with the lowest contact angles were the two Discus Dental products, Splash!® Extra Lite (XL) and Splash!® Lite (L). The results are summarized in the following graph:



NOTE:

Pseudo-equilibrium contact angles involve a time delay from surface contact to measurement to allow for the early rapid changes in contact angle which occur for some materials. The delay may be as long as 120 sec for some materials which undergo several "step-function" changes in contact angle as the equilibrium angle is approached. While shorter times are desired, longer times are avoided as they have no clinical relevance, since trapped bubbles are unlikely to be released after an impression is removed from a vibrator. For the materials tested, 30 sec was adequate to yield stable readings.

Data were analyzed by ANOVA followed by Bonferroni's multiple comparison test.

Discussion

The contact angles of the Splash!® Extra Lite and Splash!® Lite suggest that they should be exceptionally easy to pour up bubble free. The results for the other materials require some comments. The value for Impregum® F is near the values which we have previously measured. Surprise is sometimes expressed that the value is so high as the polyethers are known to be very wettable materials. However, this hydrophilicity is only historically correct. In addition to changing the stiffness of the material, the reformulation of the material (from Impregum® to Impregum® F) in 1989 also involved a substantial reduction in hydrophilicity. The original material had a contact angle near 20 degrees.

The value for 3M Express™ is unexpectedly high. Our previous measurements for Express™ Light Body material have yielded values near 18 degrees. There is no clear reason for the dramatic difference in these measurements. It is possible that Express™ has undergone a "silent" reformulation. Alternatively, the batch we received for testing may have been out of spec.

• Express™ is a registered trademark of 3M. • Aquasil™ is a registered trademark of Dentsply.
• Impregum® is a registered trademark of ESPE. • Splash!® is a registered trademark of Discus Dental.

Materials and Methods

Materials

All impression materials were supplied in their original packaging by Discus Dental. The materials, manufacturers and lot numbers are indicated in the following table.

Material	Manufacturer	Lot Number
Aquasil™ LV	DENTSPLY Caulk	980902
Express™ Lite Body – Regular Set	3M	19981209
Impregum® F	ESPE	FW0048924
Splash!® Extra Lite	Discus Dental	22-1455
Splash!® Lite Wild Berry	Discus Dental	22-1456

Methods

Tear strengths were measured according to a modification of the method of American National Standard/American Dental Association Specification No. 11, Agar Impression Materials, October 31, 1977. Note that there is no specification test for tear strength in either the ADA/ANSI or ISO specifications for elastomeric impression materials. The only modification from the published method was the reduction of the specimen thickness to approximately 2.5 mm to conserve material.

Data were analyzed by ANOVA followed by Student-Neuman-Keuls multiple comparison test.

Results and Discussions

Results

The raw data and statistical analysis are included in the Appendix. The means and standard deviations are:

Material	Tear Resistance N/mm	Standard Deviation
Aquasil™ LV	7.48	0.69
Express™ Lite Body – Regular Set	6.64	0.33
Impregum® F	9.51	0.57
Splash!® Extra Lite	7.80	0.97
Splash!® Lite Wild Berry	8.74	0.42

By SNK, each elastomer constituted a statistical subset with the exception of Aquasil™ and Splash!® Extra Lite, which were not statistically different, $p < 0.05$. Impregum® F, the polyether, had the highest tear resistance. Of the vinyl polysiloxanes tested, Splash!® Lite Wild Berry had the highest tear resistance, followed by Splash!® Extra Lite.

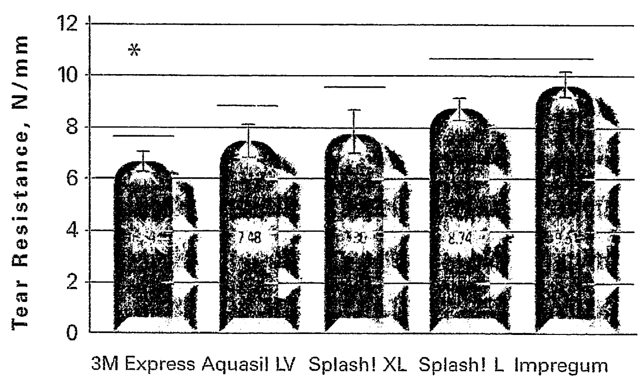
** Horizontal lines connect bars which are not statistically significantly different at the p = 0.05 level by Student-Neuman-Keuls.*

Discussion

Of the vinyl polysiloxanes, the materials with the greatest tear resistances were Splash!® Extra Lite and Splash!® Lite. While no tear resistance minimums exist in the ADA/ANSI specifications for elastomeric impression materials, it is interesting that the lowest values reported exceed the minimum for agar hydrocolloids by approximately 10 fold.

The results are summarized in the following graph:

Tear Resistance, N/mm



EVALUATION 3 Moisture Displacement

Materials and Methods

Materials

All impression materials were supplied in their original packaging by Discus Dental. The materials, manufacturers and lot numbers are indicated in the following table.

Material	Manufacturer
Aquasil™ (ADA type I)	DENTSPLY Caulk
Aquasil™ LV	DENTSPLY Caulk
Express™ Lite Body – Regular Set	3M
Impregum® F	ESPE
Splash!® Lite Wild Berry	Discus Dental
Splash!® Extra Lite Wild Berry	Discus Dental

Methods

An extracted human third molar was mounted in acrylic resin in a PVC ring with the crown exposed. Right angle grooves 1.5 mm wide by 1.5 mm deep were milled mesio-distally along the facial and lingual surfaces using a water cooled FG-57 bur in a high-speed handpiece. For ten replicates of each of six impression materials, the tooth was immersed in deionized water and removed, leaving the adherent water in the grooves, and an impression made. After curing, the impressions were sectioned bucco-lingually and photographed at 30 magnification using a digital camera on a Olympus zoom microscope. The photographs were imported into Corel Draw and magnified 4X. A circle was drawn which matched the radius of the meniscus where the impression material had failed to displace water from the tooth surface. These circle diameters were analyzed by ANOVA and post hoc multiple comparison test, and compared with previously measured contact angles by correlation analysis.

Radii were analyzed by ANOVA and Student-Neuman-Keuls multiple comparison test. Note that larger values represent poorer moisture displacement.

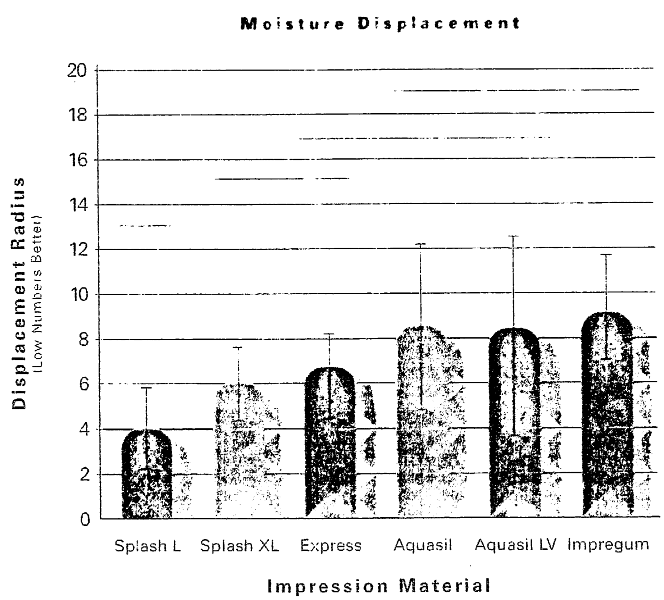
Results and Discussions

Results

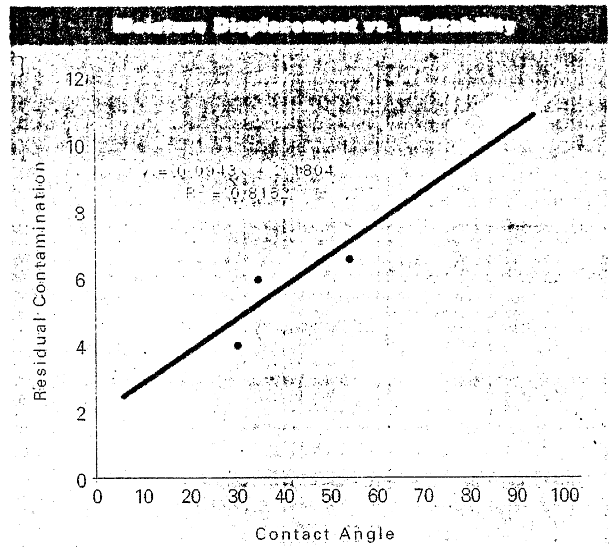
The raw data and statistical analysis are included in the Appendix. The means and standard deviations are:

Material	Tear Resistance N/mm	Standard Deviation
Aquasil™ (ADA type I)	8.582	3.7
Aquasil™ LV	8.209	4.5
Express™ Lite Body – Regular Set	6.476	1.8
Impregum F	9.264	2.3
Splash! Lite Body	3.975	1.8
Splash! Extra Lite Body	5.946	1.5

The materials fell into four statistical subsets by Student-Newman-Keuls analysis with one material, Splash!® Lite Body being significantly better than the rest. The next best statistical subset consisted of Splash!® Extra Lite and Express™, which were not different from one another at the $p \leq 0.05$ level.



Correlation analysis was performed for the five materials for which both moisture displacement and contact angle (wetting) data were available (i.e., all but Aquasil™ LV), Pierson Product Moment analysis yielded a significant correlation between contact angle and fluid displacement, R2=0.8, p=0.036.



Discussion

Splash!® Lite Body is the best material from the standpoint of moisture displacement, and significantly better than any of the other materials. The material which displaced moisture the poorest is Impregum® F. At first sight, this result will seem very surprising to many as there appears to be a general feeling among dentists that one of polyether's strengths is its ability to sweep moisture from a contaminated field. It is quite possible that this anecdotal generalization became well established before the materials were reformulated in 1989. Just as the polyethers are no longer the most wettable materials, it is also possible that they are no longer the materials best able to displace moisture. Further work and testing is clearly needed to determine whether this is, in fact, the case.

In the study, the significant correlation between moisture displacement and contact angle was somewhat surprising. Past studies of earlier vinyl polysiloxanes in both this and other laboratories had failed to find any relationship between these two variables. This correlation and the fact that all materials have markedly different contact angles than found in previous studies suggests that the materials have been reformulated to optimize moisture displacement. This reformulation would not be surprising as wettability as measured by contact angle is a good indicator of the ability to pour a bubble free cast. But the purchaser of the material is usually not the one who pours the cast. The purchaser is, however, very concerned with the ability of the material to register a usable impression, even in the presence of unavoidable moisture contamination.

Obs.	Material	MatNo	CONANG	Obs.	Material	MatNo	CONANG	Obs.	Material	MatNo	CONANG	Obs.	Material	MatNo	CONANG	Obs.	Material	MatNo	CONANG
1	Express	1	51	31	Aquasil	2	57	61	Impregum	3	78	91	Splash! L	4	29	121	Splash! XL	5	30
2	Express	1	54	32	Aquasil	2	57	62	Impregum	3	79	92	Splash! L	4	30	122	Splash! XL	5	31
3	Express	1	55	33	Aquasil	2	54	63	Impregum	3	76	93	Splash! L	4	28	123	Splash! XL	5	31
4	Express	1	54	34	Aquasil	2	55	64	Impregum	3	78	94	Splash! L	4	30	124	Splash! XL	5	33
5	Express	1	52	35	Aquasil	2	56	65	Impregum	3	80	95	Splash! L	4	28	125	Splash! XL	5	33
6	Express	1	51	36	Aquasil	2	56	66	Impregum	3	78	96	Splash! L	4	27	126	Splash! XL	5	32
7	Express	1	52	37	Aquasil	2	53	67	Impregum	3	80	97	Splash! L	4	29	127	Splash! XL	5	32
8	Express	1	53	38	Aquasil	2	52	68	Impregum	3	78	98	Splash! L	4	27	128	Splash! XL	5	33
9	Express	1	55	39	Aquasil	2	56	69	Impregum	3	79	99	Splash! L	4	28	129	Splash! XL	5	35
10	Express	1	52	40	Aquasil	2	54	70	Impregum	3	81	100	Splash! L	4	26	130	Splash! XL	5	30
11	Express	1	51	41	Aquasil	2	55	71	Impregum	3	80	101	Splash! L	4	30	131	Splash! XL	5	33
12	Express	1	53	42	Aquasil	2	57	72	Impregum	3	79	102	Splash! L	4	29	132	Splash! XL	5	31
13	Express	1	53	43	Aquasil	2	53	73	Impregum	3	81	103	Splash! L	4	29	133	Splash! XL	5	31
14	Express	1	52	44	Aquasil	2	57	74	Impregum	3	79	104	Splash! L	4	32	134	Splash! XL	5	31
15	Express	1	50	45	Aquasil	2	55	75	Impregum	3	81	105	Splash! L	4	31	135	Splash! XL	5	33
16	Express	1	52	46	Aquasil	2	57	76	Impregum	3	77	106	Splash! L	4	29	136	Splash! XL	5	31
17	Express	1	56	47	Aquasil	2	57	77	Impregum	3	76	107	Splash! L	4	28	137	Splash! XL	5	32
18	Express	1	56	48	Aquasil	2	54	78	Impregum	3	78	108	Splash! L	4	28	138	Splash! XL	5	34
19	Express	1	53	49	Aquasil	2	55	79	Impregum	3	80	109	Splash! L	4	27	139	Splash! XL	5	36
20	Express	1	51	50	Aquasil	2	57	80	Impregum	3	80	110	Splash! L	4	29	140	Splash! XL	5	34
21	Express	1	52	51	Aquasil	2	57	81	Impregum	3	79	111	Splash! L	4	29	141	Splash! XL	5	31
22	Express	1	51	52	Aquasil	2	55	82	Impregum	3	82	112	Splash! L	4	28	142	Splash! XL	5	34
23	Express	1	52	53	Aquasil	2	52	83	Impregum	3	79	113	Splash! L	4	26	143	Splash! XL	5	35
24	Express	1	54	54	Aquasil	2	55	84	Impregum	3	79	114	Splash! L	4	26	144	Splash! XL	5	33
25	Express	1	52	55	Aquasil	2	55	85	Impregum	3	81	115	Splash! L	4	27	145	Splash! XL	5	30
26	Express	1	50	56	Aquasil	2	55	86	Impregum	3	79	116	Splash! L	4	28	146	Splash! XL	5	32
27	Express	1	54	57	Aquasil	2	55	87	Impregum	3	77	117	Splash! L	4	30	147	Splash! XL	5	32
28	Express	1	51	58	Aquasil	2	56	88	Impregum	3	82	118	Splash! L	4	31	148	Splash! XL	5	32
29	Express	1	50	59	Aquasil	2	55	89	Impregum	3	80	119	Splash! L	4	31	149	Splash! XL	5	30
30	Express	1	52	60	Aquasil	2	55	90	Impregum	3	79	120	Splash! L	4	28	150	Splash! XL	5	31

Analysis of Variance

N's, means and standard deviations based on dependent variable: CONANG

** Indicates statistics are collapsed over this factor*

Factors:	M	N	Mean	S.D.
	*	150	49.5267	18.3258
	1 (Express)	30	52.4667	1.6761
	2 (Aquasil)	30	55.2333	1.4782
	3 (Impregum)	30	79.1333	1.5698
	4 (Splash! L)	30	28.6000	1.5669
	5 (Splash! XL)	30	32.2000	1.6060

Fmax for testing homogeneity of between subjects variances: 1.29
Number of variances= 5 df per variance= 29.

Analysis of Variance Dependent variable: CONANG

Source	df	SS (H)	MSS	F	P
Between Subjects	149	50039.3910			
M (MATNO)	4	49677.0900	12419.2725	4970.441	0.0000
Subj w Groups	145	362.3008	2.4986		

Post-hoc tests for factor M (MATNO)

Level	Mean	Level	Mean	Level	Mean
1	52.467	3	79.133	5	32.200
2	55.233	4	28.600		

Comparison	Scheffe'	Tukey-A*	Tukey-B*	Newman -Keuls*	Bon-ferroni	Dunnett
1 < 2	0.0000	0.0100	0.0100	0.0100	0.0000	0.0100
1 < 3	0.0000	0.0100	0.0100	0.0100	0.0000	0.0100
1 > 4	0.0000	0.0100	0.0100	0.0100	0.0000	0.0100
1 > 5	0.0000	0.0100	0.0100	0.0100	0.0000	0.0100
2 < 3	0.0000	0.0100	0.0100	0.0100	0.0000	N.A.
2 > 4	0.0000	0.0100	0.0100	0.0100	0.0000	N.A.
2 > 5	0.0000	0.0100	0.0100	0.0100	0.0000	N.A.
3 > 4	0.0000	0.0100	0.0100	0.0100	0.0000	N.A.
3 > 5	0.0000	0.0100	0.0100	0.0100	0.0000	N.A.
4 < 5	0.0000	0.0100	0.0100	0.0100	0.0000	N.A.

** The only possible P-values are .01, .05 or .10 (up to 0.0500).*
A blank means the P-value is greater than 0.0500.
For Dunnett's test only the P-values .05 and .01 are possible and only for comparisons with the control mean (level 1).

APPENDIX 2 Test Resistance Data and Statistical Analysis

Obs.	Material	MatNo	MPa	N/mm	Obs.	Material	MatNo	MPa	N/mm	Obs.	Material	MatNo	MPa	N/mm
1	Express	1	0.5206	6.560000	11	Aquasil	2	0.6104	7.672700	21	Splash! L	4	0.7302	9.066100
2	Express	1	0.5076	6.396800	12	Aquasil	2	0.6637	8.379300	22	Splash! L	4	0.7083	8.932800
3	Express	1	0.5085	6.408200	13	Splash! EL	3	0.6280	7.908700	23	Splash! L	4	0.6324	7.961500
4	Express	1	0.5056	6.371000	14	Splash! EL	3	0.5929	7.470800	24	Splash! L	4	0.7017	8.836400
5	Express	1	0.5708	7.192300	15	Splash! EL	3	0.7158	9.037700	25	Impregum	5	0.7735	9.739801
6	Express	1	0.5470	6.892400	16	Splash! EL	3	0.4852	6.125000	26	Impregum	5	0.7669	9.652800
7	Aquasil	2	0.5476	6.907600	17	Splash! EL	3	0.6541	8.244900	27	Impregum	5	0.6549	8.871600
8	Aquasil	2	0.6163	7.760000	18	Splash! EL	3	0.6370	8.040000	28	Impregum	5	0.8064	10.142901
9	Aquasil	2	0.6135	7.714300	19	Splash! L	4	0.7182	9.058800	29	Impregum	5	0.6944	8.760000
10	Aquasil	2	0.5105	6.431200	20	Splash! L	4	0.6838	8.611100	30	Impregum	5	0.7867	9.919700

Analysis of Variance

N's, means and standard deviations based on dependent variable: CONANG

** Indicates statistics are collapsed over this factor*

Factors: M	N	Mean	S.D.
*	30	8.0355	1.1779
1	6	6.6363	0.3348
2	6	7.4775	0.6938
3	6	7.8045	0.9709
4	6	8.7445	0.4188
5	6	9.5145	0.5677

Fmax for testing homogeneity of between subjects variances: 8.41
Number of variances= 5 df per variance= 5.

Analysis of Variance Dependent variable: NPERMM

Source	df	SS (H)	MSS	F	P
Between Subjects	29	40.2351			
M (MATNO)	4	30.0664	7.5166	18.480	0.0000
Subj w Groups	25	10.1688	0.4068		

Post-hoc tests for factor M (MATNO)

Level	Mean	Level	Mean	Level	Mean
1	6.637	3	7.805	5	9.514
2	7.478	4	8.744		

Comparison	Scheffe'	Tukey-A*	Tukey-B*	Newman -Keuls*	Bon-ferroni	Dunnett
1 < 2				0.0500		
1 < 3		0.0500	0.0500	0.0500	0.0400	0.0500
1 < 4	0.0002	0.0100	0.0100	0.0100	0.0000	0.0100
1 < 5	0.0000	0.0100	0.0100	0.0100	0.0000	0.0100
2 < 3						N.A.
2 < 4	0.0390	0.0500	0.0100	0.0100	0.0207	N.A.
2 < 5	0.0004	0.0100	0.0100	0.0100	0.0000	N.A.
3 < 4			0.0500	0.0500		N.A.
3 < 5	0.0028	0.0100	0.0100	0.0100	0.0010	N.A.
4 < 5				0.0500		N.A.

**The only possible P-values are .01, .05 or .10 (up to 0.0500).*
A blank means the P-value is greater than 0.0500.

For Dunnett's test only the P-values .05 and .01 are possible and only for comparisons with the control mean (level 1).

APPENDIX 3 Moisture Displacement Data and Statistical Analysis

Obs.	MatNo	Elastomr	Specimen	Side	Angle	Diameter
1	1	Splash! L	1	1	1	3.211000
2	1	Splash! L	1	1	2	6.274000
3	1	Splash! L	1	2	1	6.029000
4	1	Splash! L	1	2	2	3.603000
5	1	Splash! L	2	1	1	6.225000
6	1	Splash! L	2	1	2	0.833000
7	1	Splash! L	2	2	1	0.858000
8	1	Splash! L	2	2	2	6.102000
9	1	Splash! L	3	1	1	3.088000
10	1	Splash! L	3	1	2	3.431000
11	1	Splash! L	3	2	1	3.333000
12	1	Splash! L	3	2	2	3.284000
13	1	Splash! L	4	1	1	1.912000
14	1	Splash! L	4	1	2	4.191000
15	1	Splash! L	4	2	1	3.480000
16	1	Splash! L	4	2	2	1.740000
17	1	Splash! L	5	1	1	5.147000
18	1	Splash! L	5	1	2	5.392000
19	1	Splash! L	5	2	1	6.470000
20	1	Splash! L	5	2	2	4.902000
21	2	Splash! EL	1	1	1	4.534000
22	2	Splash! EL	1	1	2	4.926000
23	2	Splash! EL	1	2	1	4.411000
24	2	Splash! EL	1	2	2	5.000000
25	2	Splash! EL	2	1	1	5.318000
26	2	Splash! EL	2	1	2	4.142000
27	2	Splash! EL	2	2	1	4.779000
28	2	Splash! EL	2	2	2	5.514000
29	2	Splash! EL	3	1	1	7.181000
30	2	Splash! EL	3	1	2	7.205000
31	2	Splash! EL	3	2	1	5.955000
32	2	Splash! EL	3	2	2	7.867000
33	2	Splash! EL	4	1	1	7.769000
34	2	Splash! EL	4	1	2	6.078000
35	2	Splash! EL	4	2	1	6.102000
36	2	Splash! EL	4	2	2	8.308000

Obs.	MatNo	Elastomr	Specimen	Side	Angle	Diameter
37	2	Splash! EL	5	1	1	3.897000
38	2	Splash! EL	5	1	2	7.990000
39	2	Splash! EL	5	2	1	7.965000
40	2	Splash! EL	5	2	2	3.970000
41	3	IMPRE	1	1	1	6.463000
42	3	IMPRE	1	1	2	7.301000
43	3	IMPRE	1	2	1	6.952000
44	3	IMPRE	1	2	2	7.161000
45	3	IMPRE	2	1	1	8.908000
46	3	IMPRE	2	1	2	12.855000
47	3	IMPRE	2	2	1	14.357000
48	3	IMPRE	2	2	2	10.340000
49	3	IMPRE	3	1	1	7.091000
50	3	IMPRE	3	1	2	8.000000
51	3	IMPRE	3	2	1	8.279000
52	3	IMPRE	3	2	2	10.096000
53	3	IMPRE	4	1	2	9.607000
54	3	IMPRE	4	2	1	8.838000
55	3	IMPRE	5	1	1	12.052000
56	3	IMPRE	5	1	2	9.921000
57	4	EXPRESS	1	1	1	5.450000
58	4	EXPRESS	1	1	2	9.746000
59	4	EXPRESS	1	2	1	8.454001
60	4	EXPRESS	1	2	2	6.428000
61	4	EXPRESS	2	1	1	4.821000
62	4	EXPRESS	2	1	2	5.974000
63	4	EXPRESS	2	2	1	4.437000
64	4	EXPRESS	2	2	2	5.450000
65	4	EXPRESS	3	1	1	8.838000
66	4	EXPRESS	3	1	2	7.196000
67	4	EXPRESS	3	2	1	7.091000
68	4	EXPRESS	3	2	2	8.838000
69	4	EXPRESS	4	1	2	7.336000
70	4	EXPRESS	4	2	1	7.930000
71	4	EXPRESS	5	1	1	5.519000
72	4	EXPRESS	5	1	2	3.843000

Obs.	MatNo	Elastomr	Specimen	Side	Angle	Diameter
73	4	EXPRESS	5	2	1	3.528000
74	4	EXPRESS	5	2	2	5.694000
75	5	AQUASIL	1	1	1	4.656000
76	5	AQUASIL	1	1	2	13.626000
77	5	AQUASIL	1	2	1	11.298000
78	5	AQUASIL	1	2	2	4.877000
79	5	AQUASIL	2	1	1	8.235000
80	5	AQUASIL	2	1	2	16.518000
81	5	AQUASIL	2	2	1	15.734000
82	5	AQUASIL	2	2	2	8.410000
83	5	AQUASIL	3	1	1	11.715000
84	5	AQUASIL	3	1	2	5.343000
85	5	AQUASIL	3	2	1	5.220000
86	5	AQUASIL	3	2	2	11.053001
87	5	AQUASIL	4	1	1	8.308000
88	5	AQUASIL	4	1	2	7.646000
89	5	AQUASIL	4	2	1	8.357000
90	5	AQUASIL	4	2	2	8.088000
91	5	AQUASIL	5	1	1	3.676000
92	5	AQUASIL	5	1	2	7.892000
93	5	AQUASIL	5	2	1	6.372000
94	5	AQUASIL	5	2	2	4.607000
95	6	AQUALV	1	1	1	4.995000
96	6	AQUALV	1	1	2	10.515000
97	6	AQUALV	1	2	1	10.655000
98	6	AQUALV	1	2	2	5.310000
99	6	AQUALV	2	1	1	3.284000
100	6	AQUALV	2	1	2	3.843000
101	6	AQUALV	2	2	1	3.528000
102	6	AQUALV	2	2	2	3.423000
103	6	AQUALV	3	1	1	8.349000
104	6	AQUALV	3	2	2	8.838000
105	6	AQUALV	4	1	1	10.026000
106	6	AQUALV	4	1	2	16.733000
107	6	AQUALV	4	2	1	16.209000
108	6	AQUALV	4	2	2	9.222000

Analysis of Variance

N's, means and standard deviations based on dependent variable: DIAMETER

** Indicates statistics are collapsed over this factor*

Factors:	M		N	Mean	S.D.
	*		108	6.9423	3.2371
	1	Splash! LB	20	3.9753	1.7974
	2	Splash! XL	20	5.9456	1.5146
	3	Impregum	16	9.2638	2.2814
	4	Express	18	6.4763	1.8137
	5	Aquasil	20	8.5815	3.7023
	6	Aquasil LV	14	8.2093	4.4684

Fmax for testing homogeneity of between subjects variances: 8.70
Number of variances= 6 df per variance= 17.

Analysis of Variance Dependent variable: DIAMETER

Source	df	SS (H)	MSS	F	P
Between Subjects	107	1121.2554			
M (MATNO)	5	362.2941	72.4588	9.738	0.0000
Subj w Groups	102	758.9612		7.4408	

Level	Mean	Level Mean	Increasing Order	S - N - K
1	3.975	Splash! LB	1 Splash! LB	|
2	5.946	Splash! XL	2 Splash! XL	|
3	9.264	Impregum	4 Express	| |
4	6.476	Express	6 Aquasil LV	| |
5	8.582	Aquasil	5 Aquasil	| |
6	8.209	Aquasil LV	3 Impregum	|

Post-hoc tests for factor M (MATNO)

Comparison	Scheffe'	Tukey-A*	Tukey-B*	Newman -Keuls*	Bon-ferroni	Dunnett
1 < 2				0.0500		
1 < 3	0.0000	0.0100	0.0100	0.0100	0.0000	0.0100
1 < 4			0.0500	0.0500		0.0500
1 < 5	0.0001	0.0100	0.0100	0.0100	0.0000	0.0100
1 < 6	0.0025	0.0100	0.0100	0.0100	0.0004	0.0100
2 < 3	0.0277	0.0100	0.0100	0.0100	0.0070	N.A.
2 < 4						N.A.
2 < 5			0.0500	0.0500	0.0431	N.A.
2 < 6				0.0500		N.A.
3 > 4		0.0500	0.0500	0.0500		N.A.
3 > 5						N.A.
3 > 6						N.A.
4 < 5						N.A.
4 < 6						N.A.
5 > 6						N.A

**The only possible P-values are .01, .05 or .10 (up to 0.0500). A blank means the P-value is greater than 0.0500.*

For Dunnett's test only the P-values .05 and .01 are possible and only for comparisons with the control mean (level 1).

ADDITIONAL COMMENTARY Barry K. Norling, Ph. D

Beginning two decades ago, we showed that vinyl polysiloxane impression materials could be improved by additions of carefully selected surfactants. We were addressing the number one complaint about those newly introduced materials. While incredibly dimensionally accurate and dimensionally stable, these "addition silicone" impressions were exceptionally difficult to pour up without trapping air bubbles. Most manufacturers adopted our methods and produced new "hydrophilic" materials that were wettable – in one case as wettable as the water-based hydrocolloid materials. But it wasn't long before some manufacturers recognized that they might have solved the wrong problem: the dentists who purchased the impression materials didn't pour impressions up. The dentists were more interested in materials which were "forgiving", a term most often taken to mean usable even when the field was somewhat contaminated by oral fluids. Before long, some advertising copy began implying that the hydrophilic vinyl polysiloxanes were capable of displacing moisture from contaminated fields. But academic researchers like ourselves showed that was not the case. Wettability from the standpoint of ease of impression pouring was essentially unrelated to the ability to sweep contamination aside.

Recently, manufacturers have modified their materials with an eye to making them more able to displace moisture. The side effect has been an increase in the contact angle measured with a drop of slurry water. But that really isn't a problem because as long as the angle is below 70 degrees or so, the materials are relatively straightforward to pour up; it is just the unmodified materials with contact angle exceeding 90 degrees that are exceptionally difficult. When measured today, few materials yield the same contact angles that they had a few years ago. The obvious question is "were hese efforts successful?"

To find out, we devised a new simple test of the ability to displace moisture. We machined a natural tooth so that the occlusal table was flat, and then machined two 90-degree ledges on the lingual and buccal surfaces. The mounted tooth is dipped into water (occlusal surface down) and withdrawn, leaving the ledges filled with clinging water. The tooth is then lowered into a bottle cap "tray" containing the impression material. After setting, the impression is sectioned perpendicular to the ledges. If the water were completely displaced, the 90 degree ledges would have sharp angles with zero radii. In reality, there is always a residual meniscus of undisplaced water. By measuring the radius of that meniscus, the degree to which the impression material displaces moisture can be measured. By comparing the average radii for commercial materials, one can judge their relative ability to displace moisture.

In our tests, one material – Splash!® Lite Body – was a standout, producing a radius statistically lower than those of all other materials. Its brand mate, Splash!® Extra Lite Body, followed it. Interestingly, the polyether material Impregum® yielded the highest mean meniscus radius. That is surprising because "polyether" is synonymous with "forgiving" in many dentists' minds. The result may be explained by the fact that the polyethers were modified about twelve years ago to make them less stiff. In the process, they also became less wettable and less able to displace moisture.

In summary, the newly modified vinyl polysiloxane materials are successful at meeting their new goal of displacing moisture. But some are more successful than others. While every dentist is obliged to maintain a field as contamination free as possible, when zero contamination is impossible, materials like Splash!® should significantly improve the chances of getting a usable impression.

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