

The effect of pouring time and storage condition on the accuracy of irreversible hydrocolloid impressions.

Kifah Dafi Jamani, BDS, PhD

لقد كان الهدف من هذه الدراسة معرفة الوقت المناسب وطريقة الحفظ الأمثل عند صب طبعات مادة الإلجينات المستعملة لعمل التعويضات الجزئية المتحركة والمصنوعة من مادة كروم كوبالت. اشتملت الدراسة على ٢٤ طبعه لنموذج بلاستيكي يمثل الفك العلوي، تم حفظ الطبعات قبل صبها بمادة الجبس بإحدى طريقتين، الأولى بوضع الطبعه داخل كيس بلاستيكي مغلق والأخرى عن طريق لف الطبعه بالشاش الرطب. تم صب الطبعات بسعد ١٥ دقيقة، ٣٠ دقيقة، ساعة واحدة وبعد ثلاث ساعات. تم استعمال (Deltronic Profile Projector) بقوة تكبير عشرة مرات وموصول بالكمبيوتر لإعطاء القراءات المطلوبة. إن نتائج هذه الدراسة تبين أن التغيرات البعدية بعد ١٥ دقيقة للطبعات المحفوظة في أكياس مغلقة تراوحت ما بين (صفر-٢٢٨، ملم) وأن التغيرات البعدية بعد ثلاث ساعات تراوحت ما بين (٠،٢٢ - ٠،٢٧٢ ملم) بينما التغيرات البعدية بعد ١٥ دقيقة للطبعات المحفوظة بالشاش المبلل تراوحت ما بين (٠،١١ - ٠،١٥٣ ملم) وأن التغيرات البعدية بعد ثلاث ساعات تراوحت ما بين (٠،٩٢ - ٠،١٤٥ ملم). لقد دلت نتائج هذه الدراسة أن طبعات مادة الإلجينات إن صببت مباشرة يمكن استعمالها كطبعات نهائية لصناعة الأطعم الجزئية المعدنية دون خوف من تأثير التغيرات البعدية التي قد تنتج، لكن إذا تعذر صب الطبعات مباشرة فيجب أن تحفظ الطبعه بلفها بالشاش المبلل بالماء وصيها قبل ثلاث ساعات.

The purpose of this investigation was to determine the best storage condition and time for pouring irreversible hydrocolloid impression material. Twenty-four irreversible hydrocolloid impressions were made of a maxillary plastic full arch dental model. Two storage conditions were used: storage in sealed bags and wrapping impressions with wet towels. Pouring of the impressions was carried out at 15 min, 30 min, one hr and three hrs after impression making. A Deltronic Profile Projector with x 15 times magnification together with a Computer Aided Analytical Geometry Program were used for measurement. The results of this study indicated that the magnitude of dimensional changes of irreversible hydrocolloid impressions stored in sealed bags and poured after 15 min ranged from zero to 228 μ m, and that for those poured after 3 hour ranged from 22 to 272 μ m. The dimensional change of casts made from impressions wrapped with wet towels and poured after 15 min ranged from 11 to 153 μ m, while that for impressions poured after 3 hrs ranged from 92 to 145 μ m. No statistically significant difference was found between the master model and casts from 15 min pouring time ($P>0.05$). However, for 3 hrs pouring time and sealed bag storage condition, it was shown to be significantly different in respect to horizontal distances between left and right first molars ($P=0.0017$). If irreversible hydrocolloid impression pouring is to be delayed up to three hrs, then it should be wrapped with a wet towel and poured within 3 hrs, as this did not appear to affect their accuracy significantly. Irreversible hydrocolloid could be used as a final impression material for construction of Co.Cr. removable partial denture provided that the impression is poured within 15 min.

Introduction

Since the introduction of irreversible hydrocolloid impression material, evidence of dimensional changes as a result of synergesis or evaporation of water when exposed to air was one of its shortcomings.¹ Therefore, there had always been the question of whether or not irreversible hydrocolloid impression materials are accurate enough for restorative and prosthetic dental use.²

Skinner et al.³ compared the accuracy of reversible and irreversible hydrocolloid impression materials. They concluded that if hydrocolloid impression was poured within 10 min no serious error should be expected. Dahl et al.⁴ concluded that clinically accepted working casts could be obtained from irreversible hydrocolloid impressions stored in a 100% relative humidity and poured within three hrs. Peutzeldt and Asmussen⁵ compared seven elastomeric impression materials and three irreversible hydrocolloid impression materials and found that all impression materials when poured 24 hrs after setting showed a net shrinkage resulting in too large a die stone and incomplete seating. They also reported that inaccuracy of irreversible hydrocolloid varied

between 44 μ m and 188 μ m while that of elastomeric materials varied between 39 μ m and 130 μ m.

Eriksson et al.⁶ studied the accuracy of one reversible, seven irreversible hydrocolloids and two addition silicones under storage periods of 15 min, 2 hrs and 95 hrs respectively. Their results indicated that irreversible hydrocolloids poured within 2 hrs had an accuracy similar to that of reversible Hydrocolloids and addition silicon. Cohen et al.⁷ studied the dimensional stability of three different irreversible hydrocolloid impression materials under five different storage conditions. The impressions were stored with wet towel for different periods of: 10 min, 30 min, one hr and 24 hrs before pouring. They found that the immediate method produced more accurate cast for the irreversible hydrocolloid impression materials studied.

The aim of this investigation was to evaluate the effect of storage time on the accuracy of gypsum casts poured from irreversible hydrocolloid impression material and stored in two different storage conditions, sealed bag storage and wet towel storage.

Received 22 January 2002; Revised 20 April and 19 May 2002;
Accepted 21 May 2002
Associate Professor, Department of Conservative Dentistry
and Prosthodontics, Faculty of Dentistry
The University of Jordan

Address reprint requests to:
Dr. K. D. Jamani
P. O. Box 1089
Amman 11821
Jordan
E-mail: dr-zoubi@jonet.com

Material and Methods

A pilot study was carried out using three irreversible hydrocolloid impression materials* (Cavex Chromatic, Cavex Holland BV P.O. Box 852, 2003 RW Haarlem, Holland, Phase Plus, Zhermack P.O. Box 95 45021 Badia Polesine, Italy and Hydrogum, Zhermack P.O. Box 95 45021 Badia Polesine, Italy) to make impressions for a maxillary plastic full arch dental model** (Frasaco, Franz Sachs&Co.GmbH D88061 Tettang/Germany). Three impressions were made with each of the three materials. The impressions were poured with gypsum die stone¹ (Tecstone, Garreco P.O.Box 8, Heber springs, AR 72543, USA). Storage conditions, and measurements at 15 min and at three hrs of the casts were performed as described below. No significant difference was found among the three hydrocolloid impression materials. Therefore Cavex Chromatic was chosen as a representative of hydrocolloid impression materials to be used in this study.

Twenty-four irreversible hydrocolloid impressions were made for a maxillary plastic full arch with the 2nd and 3rd molars removed from the plastic model in order to facilitate the measurements of the distal surfaces of the first molars. All metal perforated trays were modified with brown compoundⁱⁱ (Harvard, Harvard dental GmbH D-14197 Berlin) in order to completely house the plastic model so that the model could be placed in the tray at the same position for each impression. Trays were sprayed with an adhesive (Tray-Tack, PSP Dental Co.ltd Belvedere Kent.U.K.) before loading with irreversible hydrocolloid. The plastic model was rinsed with running tap water prior to impression making. Irreversible hydrocolloid was weighed and mixed according to the manufacturer's recommendations. The impressions were poured with dental stone. The manufacturer's recommendations regarding the stone/water ratio were adhered to. Mixing of stone was carried out manually for 5 seconds and then for 20 seconds in a vacuum-mixing machine (Multivac 4 Degussa, Degussa AG GB Dental D6000 Frankfurt). A vibrating machine (Vibrator R2 Degussa) was used to pour all impressions with gypsum die stone. All impressions were made and poured by the investigator.

The impressions were divided into two groups, of 12 impressions each. Impressions of the first group were rinsed with water and stored in sealed plastic bags and they were divided into four subgroups each of three impressions. Then the

first subgroup was poured with gypsum die stone after 15 min, the second subgroup after 30 min, the third subgroup after one hr, and the fourth subgroup after three hrs. The impressions of the second group were wrapped with wet towels (wetness of towels was standardized by soaking it in water squeezed for 10 seconds between two glass slabs, before they were used to wrap the impressions). Then they were divided into four subgroups. The impressions of the subgroups of the second group were poured with gypsum die stone at time intervals similar to those of the first group. The stone casts were recovered after one hr. The data were analyzed using students t-test an established level of confidence of 0.05.

Measurements

A profile projector, Fig. 1 (Deltronic Model DV 114 Computer) with x15 magnification was utilized for measurements of the stone casts. The casts were placed on a movable table connected to a monitor where movements in the X and Y directions could be displayed and measured with an accuracy of 1 μ m. Each measurement was repeated 5 times to calculate the means and standard deviations.



Fig. 1. The profile projector used in the study.

A computer aided analytic geometry program (CAAG) (prepared by the Jordanian Royal Scientific Society, Amman Jordan) was used to trace and measure the circumference of the left first molar, right first molar and left central incisor when the casts were viewed from above. While for the length of the first molar the tooth was viewed from the distal aspect of the cast and the length was measured from the highest occlusal point (the cusp tip) to the crest of gingival margin. The Master Cam Program was used to draw a tangent on the distal and palatal aspects of the circumferences of the left and right first molars (Fig. 2) the distance

between the two points resulting was measured as the distance in the X direction L1. The distance between the palatal tangent on the circumference of the left central incisor in the Y direction and L1 is referred as L2. The measurements of undercut were made by viewing the first molar from the distal aspect. A tangent to the buccal maximum contour (survey line) was drawn from the level of the cusp tip and the undercut value was measured as the distance between this line and the tooth structure in the cervical area at 7 mm from the cusp tip.

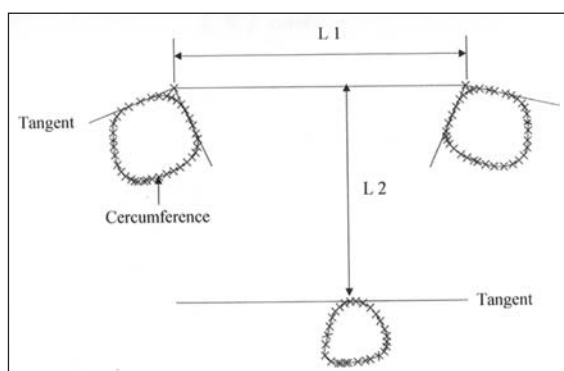


Fig. 2. A diagram illustrating the L1 (the distance between the left and right first molars) and L2 (the distance between the palatal tangent of the left central incisor and L).

Results

Table 1 presents the dimensional changes and standard deviation of tooth length, undercut, L1 and L2 for both the master model and stone casts poured at various storage time and sealed bag storage conditions.

Since the impression materials is rigidly retained in the impression trays, the most probable interpretation of the data is that a "plus" error may be due to a contraction of the impression material and that a "minus" error may be the result of expansion of the impression material.

Table 2 shows the dimensional change values for stone casts recovered from irreversible hydrocolloid impressions wrapped with wet towels and poured 15 min, 30 min, one hr and three hrs after impression making. Fig. 3 shows the two curves representing changes in tooth length versus time of pouring for the two storage conditions. It is evident that changes occurred with delay of pouring and these changes was ranged between +62 μm at 30 min and -141 μm at 3 hrs pouring time.

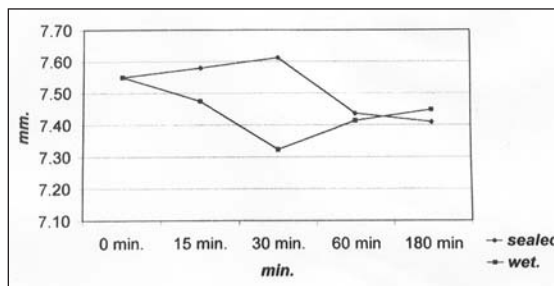


Fig. 3. The influence of storage condition and pouring time of irreversible hydrocolloid impressions on the tooth length.

Table 1. The mean values of measurements for stone casts made of irreversible hydrocolloid impressions stored in sealed bags and poured with gypsum die stone at interval times with the dimensional change in μm and standard deviation in parenthesis.

| | Master model (mm) | 15 min. (μm) | 30 min. (μm) | 1 hr. (μm) | 3 hrs. (μm) |
|----------|-------------------|---------------------------|---------------------------|---------------------------|---------------------------|
| Length | 7.55 (0.001) | 7.55 0.00 (0.14) | 7.612 +6.2 (0.12) | 7.436 -114 (0.048) | 7.409 -141 (0.098) |
| Undercut | 0.601 (0.000) | 0.527 -7.4 (0.056) | 0.489 -112 (0.031) | 0.54 -151 (0.028) | 0.419 -182 (0.064) |
| L1 | 38.62 (0.003) | 38.684 +6.4 (0.348) | 38.912 +292 (0.225) | 39.077 +457 (0.313) | 38.642 +2.2 (0.028) |
| L2 | 28.23 (0.001) | 28.002 -228 (0.462) | 28.188 -4.2 (0.169) | 27.975 -255 (0.039) | 27.958 -272 (0.018) |

Table 2. The mean value of measurements for stone casts made of irreversible hydrocolloid impressions wrapped with wet towels and poured with gypsum die stone at interval times with dimensional change in μm and standard deviation in parenthesis.

| | Master model (mm) | 15 min. (mm) | 30 min. (mm) | 1 hr. (mm) | 3 hrs. (mm) |
|----------|-------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| Length | 7.55 (0.002) | 7.475 -7.5 (0.075) | 7.323 -227 (0.028) | 7.413 -137 (0.113) | 7.448 -102 (0.162) |
| Undercut | 0.601 (0.001) | 0.496 -105 (0.038) | 0.457 -144 (0.037) | 0.483 -118 (0.005) | 0.501 -100 (0.018) |
| L1 | 38.62 (0.001) | 38.609-1.1 (0.261) | 38.732+112 (0.029) | 38.509-111 (0.161) | 38.522-9.8 (0.241) |
| L2 | 28.23 (0.002) | 28.077-153 (0.172) | 28.283+5.3 (0.046) | 28.067-163 (0.170) | 28.085-145 (0.172) |

Although the curve representing the length values of the casts made from impressions wrapped with wet towels showed that the impressions expanded (negative figures) for the

first 30 min (-227 μ m) from the master model and then shrank back, after three hrs (-102 μ m), but this shrinkage was not statistically significant.

The dimensional changes of stone casts in the undercut area at the buccal aspect of the first molar are presented in Fig. 4. It appears that impressions stored in a sealed bag showed a continuous expansion with the delay of pouring and varied between 7.4 μ m and 182 μ m at time intervals. While impression wrapped with wet towel demonstrated a degree of expansion at the first 15 min and 30 min pouring time of 105 μ m, -144 μ m respectively, this expansion did not continue. It was followed by a degree of contraction after one hr and three hrs of 118 μ m, -100 μ m respectively. Both storage conditions produced casts with smaller undercut compared with the master model.

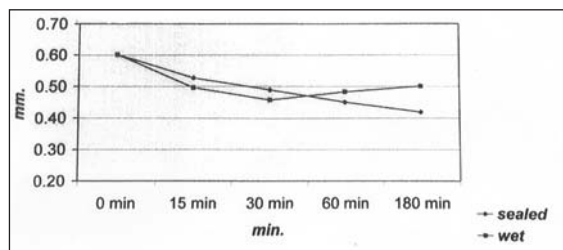


Fig. 4. The influence of storage condition and pouring time of irreversible hydrocolloid impression on the tooth undercut.

The distance between the two molars L1 is shown in Fig. 5. All impressions stored in sealed bags demonstrated statistically significant degree of changes, the amount of changes being +6.4 μ m after 15 min, +292 μ m after 30 min +457 μ m after 1 hr and +22 μ m after 3 hrs respectively. While in the case of impressions wrapped with wet towels the L1 distances was decreased by 98 μ m after three hrs, there was no statistically significant difference between casts poured at interval times.

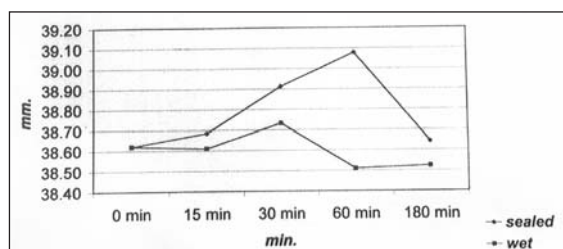


Fig. 5. The influence of storage condition and pouring time of irreversible hydrocolloid impressions on the distance between the left and right first molars (L1).

Fig. 6 represents the curves of L2 distance. Both storage conditions gave a shorter distance, but the figures taken from stone casts made from impressions wrapped with wet towels were closer to the master model. However, in the case of impressions stored in sealed bags there was a statistically significant difference between casts poured after 3 hrs and those poured after 15 min, 30 min and one hr.

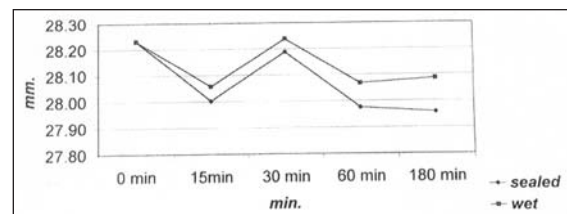


Fig. 6. The influence of storage condition and pouring time of irreversible hydrocolloid impressions on the distance between the palatal tangent of the left central incisor and the straight line between the left and right first molars (L2).

Discussion

There is no universal standard for clinically acceptable dimensional changes of hydrocolloid impression materials.

Christensen⁸ and Peters⁹ reported that inaccuracy up to 78 μ m and 50 μ m respectively are acceptable. Their studies dealt with accuracy between the dies and crowns. In the present investigation, the accuracy of casts made for construction of Cobalt Chromium removable partial dentures was the issue. There are no literature information on the acceptable inaccuracy in casts used for the construction of Cobalt Chromium removable partial dentures. Inaccuracy of up to 150 μ m might be considered acceptable as this discrepancy could be easily adjusted at the metal framework try-in stage by grinding of metal.¹⁰

In respect to undercut and tooth length, the results of this investigation indicated that irreversible hydrocolloid impressions, when poured within three hrs of impression making and kept in either of the storage conditions used in this study, showed no statistically significant changes in tooth length or tooth undercut. These findings are in close agreement with those of Peters and Telman⁹ who stated that storage of hydrocolloid impressions for up to 3 hrs in 100% relative humidity did not affect the accuracy significantly.

Regarding the accuracy in horizontal direction L1, the results indicated that both storage

conditions could produce an acceptable accuracy if pouring is carried out after 15 min of impression making. However, stone casts produced from impressions stored in sealed bags and poured after 3 hrs resulted in a statistically significant changes in L1 values compared with those produced from impressions poured after 15 min of impression making ($P = 0.0017$). When the impressions were wrapped with wet towels there were no statistically significant changes in L1 values if the impressions were poured within 3 hrs. In respect to anteroposterior accuracy, L2, Fig. 6 showed that regardless of the storage condition, the impressions shrank at the beginning, then expanded and shrank afterwards. The afterward shrinkage continued to take place in case of sealed bags storage condition resulting in statistically significant differences in L2 values between casts poured after 15 min and those poured after 3 hrs ($P = 0.0015$). In the case of wet towel storage condition this shrinkage was followed by an expansion leading to a dimensionally acceptable casts since there was no statistically difference between the original cast and those recovered from impressions poured after 3 hrs.

Conclusions

Regardless of storage condition a 15 min pouring time of hydrocolloid impressions had little effect on the distance changes between the left and right molars, the length of crowns and the undercut. No statistically significant differences were found between the master model and castes resulted from 15 min pouring time ($P > 0.05$). However the three hrs pouring time and sealed bag storage condition were shown to be significantly different in respect of the horizontal distances between the left and right molars ($P = 0.0017$).

Thus storage of impression for up to 3 hrs in wet towels did not appear to affect the accuracy significantly.

References

1. Wilson HJ, Mansfield MA, Heath JR, Spence D. Dental technology and materials for students. 8th ed., Oxford: Blackwell Scientific Publications, 1987: 18.
2. Hollenback GM, Smith DD. A further study of the physical properties of elastic impression materials. J South California DA 1956; 33: 32-36.
3. Skinner EW, Hoblit NE. A study of the accuracy of hydrocolloid Impressions J Prosthet Dent 1956; 6: 80-86.
4. Dahl B, Dymbe B, Valderhaug J. Bonding properties and dimensional stability of hydrocolloid impression systems in fixed prosthodontics. J Prosthet Dent 1985; 53: 796-800.
5. Peutzfeldt A, Asmussen E. Accuracy of alginate and elastomeric impression materials. Scand J Dent Res 1989; 97: 375-379.
6. Eriksson A, Eriksson G, Lockowandt P. Accuracy of irreversible hydrocolloids (alginates) for fixed prosthodontics. Eur J Oral Scin 1998; 106: 651-660.
7. Cohen BI, Pagnillo M, Deutsch AS, Musikant BL. Dimensional accuracy of three different alginate impression materials. J Prosthet Dent 1995; 4: 195-199. Christensen GJ. Marginal fit of gold inlay castings. J Prosthet Dent 1966; 16: 297-305.
8. Peters MC, Tieleman A. Accuracy and dimensional stability of a combined hydrocolloid impression system. J Prosthet Dent 1992; 67: 873-878. Rudd RW, Rudd KD. A review of 243 errors possible during the fabrication of a removable partial denture: 11. J Prosthet Dent 2001; 86: 262-276.

Acknowledgement

The author would like to express her sincere gratitude to Dr. Maha Al-Amad for helping during impressions preparation and to Mr. Osama Melhem from the Royal Scientific Society for his help in preparing the computer software program (CAAG).

This study was financially supported by the Deanship of Scientific research at the University of Jordan.