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CHANGES IN DENTURES DURING STORAGE IN WATER AND IN SERVICE

by

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Abstract

Changes occurring during two years in 73 clinical and 48 technic dentures, made of 12 types of denture bases showed that: (1) except for slight shrinkages of hard rubber and vinyl-acrylic copolymer there was a posterior linear expansion of from 0.02 to 1.60 per cent; (2) clinical dentures were generally as dimensionally stable as technic dentures stored in water; (3) no significant warpages occurred; (4) none of the dimensional changes affected the fit of the dentures; and (5) three upper dentures fractured, one from a blow, the other two during chewing. Teeth came out of the high expanding dentures made of an epoxy resin.

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1. INTRODUCTION

Many dentists believe that the presently available resin denture base materials distort severely in clinical service. This idea persists although many published reports give data to the contrary [1-8]. Some dentists claim to prevent such failures by employing a cast metal base. Yet a metal base will not necessarily fit the cast better than an acrylic resin base. In fact, recent data indicate rather poor accuracy for some of the cast chromium-cobalt alloys[9]. Lytle [10,11], demonstrated that the oral tissues are distorted severely in a few days by ill-fitting dentures. These distortions change the contour of the mucosa to a far greater degree than does the slight inaccuracy in dimension that develops during processing or in using an acrylic resin or metal base.

This report shows the magnitude of dimensional changes that occur in clinical resin dentures and relates these values to the fit and serviceability of the dentures after about two years; also it correlates the dimensional changes of thin and thick technic dentures stored in water at a constant temperature with changes in clinical dentures made of the same materials. Such information will aid in predicting dimensional changes in clinical dentures on the basis of laboratory tests on technic dentures.

2. METHODS AND MATERIALS

The data in this report are a continuation of the scheduled measurements on the same group of technic and clinical dentures for which the dimensional changes during processing were shown [8]. Representatives of twelve different types of organic denture bases and the number of technic and clinical dentures of each type on which measurements were made are shown in Figures 1 and 2.

The polished clinical dentures were mounted on a Hanau Model articulator using a new centric interocclusal record obtained in the mouth. Occlusal corrections in both centric occlusion and the eccentric positions were then made prior to giving the dentures to the patient. Twenty-four and forty-eight hour post-insertion appointments were scheduled for all patients and adjustments were made where necessary. These and any subsequent adjustments were recorded. Thus, all patients were observed closely during the first weeks. Three to eight months later in 1958 and during the summers of 1959 and 1960, the fit and serviceability of each denture were evaluated by: (1) photographing pressure-indicator paste patterns; (2) checking occlusal relationships; (3) noting resistance to dislodgement when force was applied vertically with the dentist's thumb or index finger to the right and left first molars and to the central incisors; (4) checking the fit of the denture on the original gypsum cast when it could be saved in the deflasking and (5) obtaining the patient's opinion.

At the time of the first evaluation in 1958 photographs of the pressure-indicator paste patterns were also obtained on the patients' old dentures, which had been retained by the authors. The detailed findings of the clinical evaluation of the newer dentures made two and three years after insertion and possible correlations between the physical properties of the resin bases and the behavior of clinical and technic dentures will be given in subsequent reports.

3. DISCUSSION OF RESULTS

3.1 Changes in Dimensions

Average changes. The average molar-to-molar changes in dimension (during processing, on storage in water for 18 months or in use) of upper technic and clinical dentures made of 12 types of denture bases are shown in Figure 1. Similar data for the lower dentures are in Figure 2.

Without exception the average molar-to-molar shrinkage of the upper dentures from the cured denture in the flask through polishing and one day in water was less than that of the lower dentures regardless of the composition of the base. The average linear shrinkage of the 68 uppers was 0.33 per cent; that of the 53 lowers, 0.50 per cent. Eighteen months later the average shrinkage of the upper dentures with the exception of Epoxolon was 0.22 per cent; that of the lowers, 0.34 per cent. This is consistent with previous findings [6,7,12,13]. The Epoxolon upper dentures expanded 0.87 per cent and the lowers expanded 0.84 per cent.

With one exception (Epoxolon), the most significant average dimensional change in the bases occurred when the dentures were removed from their gypsum casts, polished, and stored in water for one day. The average shrinkages on all of the bases ranged from 0.12 per cent (upper Epoxolon denture) to 0.70 per cent (lower Vacalon denture). Differences of this order were not detected by the dentist when placing the dentures in the mouth. Consequently, no superiority in the initial fit of the dentures constructed of the various bases was noted. Previous work on one patient indicated that considerably larger dimensional change in a denture was necessary before the change could be detected clinically [14].

Most dentures expand on storage in water or in use because of the sorption of water by the resin base. This expansion generally compensates in part for the curing shrinkage (Figures 1 and 2 and Table 1). The expansion of the 18 month old Epoxolon dentures, however, was 6.7 times their curing shrinkage. This expansion had not stopped at the end of 24 months when this report was prepared. The dentures made of the vinyl-acrylic copolymer (Luxene 44) and of vulcanite shrank slightly [0.10 per cent and 0.15 per cent, respectively (Table 1)] over the 18 month period while the other dentures expanded. Dentures of these two materials then would not be as accurate a reproduction of the wax dentures after 18 months in water or in use as they were immediately after processing and polishing. This is consistent with previous findings [15,16]. Conversely, dentures made from all the other materials, except Epoxolon, would be more accurate reproductions after 18 months than immediately after processing and polishing. The relative accuracy of the various bases is given in the last column of Table 1. The ideal value would be zero. Theoretically the more the deviation from this ideal the less satisfactory would be the fit of the denture. However, small differences in dimensional accuracy among most of the bases are purely academic and require precise laboratory measurements to detect. Even the large differences among the bases (Figures 1 and 2 and Table 1) could not be detected clinically. Most of the clinical dentures fit well after 18 months. A few fit poorly after this period. Some of these fitting well were made of each of the materials tested and the poorly fitting dentures were distributed in the range of dimensional changes shown.

No pattern or trend in superiority of clinical fit was noted for any material or processing technic either at the time of insertion or 18 months later.

Individual denture changes. In 1950-1952, a series of clinical dentures of self-curing and heat-curing acrylic resins were made at the National Bureau of Standards and at several hospitals of the Veterans Administration. The dimensional changes of these dentures during the first two years of clinical service were published[4]. Remeasurements were made of the available dentures that had suitable reference lines after more than six years. The average flange-to-flange changes during the six years were -0.29 per cent for six self-cured uppers; -0.08 per cent for four heat cured uppers; +0.30 per cent for two self-cured lowers and +0.25 per cent for four heat-cured lowers[5]. The flange-to-flange changes on the upper dentures, both self- and heat-cured, for six years more or less, are shown in Figure 3; those for lower dentures in Figure 4. The initial measurements were obtained when the dentures were delivered to the patients. Gross generalizations must be made as there were only 16 dentures on which the six-year measurements could be taken. The uppers usually shrank slightly and the lowers expanded slightly. The largest linear changes amounted to slightly less than 0.08 per cent or about 0.5 mm over the six years. The largest changes after the first year were about forty microns (40 μ) yearly on the average. These did not adversely affect the fit or serviceability of the dentures and could not be detected clinically by the patient or the dentist.

On nine of the 16 six-year old dentures the reference lines were suitable for molar-to-molar measurements. In seven of these nine dentures the difference between the molar-to-molar and the flange-to-flange changes was 0.2 mm or less; in the two self-cured lowers the difference was about 0.4 mm. So there was no significant warping or distortion of either the self-cured or heat-cured dentures.

The self-cured dentures generally changed slightly more than the heat-cured dentures. This may reflect the greater stiffness and strength of the heat-cured denture base resins[17]. The slight differences, however, have no practical significance.

Comparison of changes in technic and clinical dentures.

The average molar-to-molar change on processing, polishing and storage in water for one day of the 71 clinical dentures was generally between the average change for the thin and the average change for thick technic dentures made of the same materials. Shortly after this, the clinical dentures were inserted while the technic dentures remained stored in water at 23 ± 1°C. (73.4 ± 2°F). Subsequent dimensional changes that occurred in some upper dentures are shown in Figure 5. Lower dentures had a similar pattern. The same general pattern of shrinkage upon removal from the cast and on polishing is followed by a gradual expansion during the first three or four months at which time relative dimensional equilibrium usually is reached for both the technic and clinical dentures (Figure 5).

The molar-to-molar changes in the individual clinical dentures were within the range of ± 0.15 mm. of those in the thin and thick technic dentures of corresponding bases, with the exception of the five upper Epoxolon clinical dentures which expanded 0.2 to 0.5 mm. more than the technic Epoxolon dentures.

Usually the forces to which the denture was subjected in use did not cause appreciable permanent dimensional change. Apparently, practically all the change in dimension after polishing was caused by sorption of water.

Some small differences in dimensional changes of clinical dentures in use and of technic dentures in water for 18 months are shown on the right in Figure 6. The average percentage expansions in use or in water shown on the right compensate in part for the processing shrinkages on the left. The average molar-to-molar expansion of the clincal dentures in use was greater than for either the thin or thick technic dentures in water. The average differences are small, running from 0.11 to 0.17 per cent. It may be that the slightly greater expansion of the clincal dentures was caused by their flexure in saliva at 37°C. (98.6°F.) as the technic dentures were at rest in water at 23°C. (73.4°F.).

The thick technic dentures expanded slightly more during 18 months of storage in water than did the thin technic dentures (Figure 6). This higher expansion coupled with a low processing shrinkage indicates that the thick technic dentures are consistently more stable in dimension than the thin technic dentures.

<u>Warpage index.</u> Warpage index in this report is defined as the difference in percentage change between the molar-to-molar and the flange-to-flange distances. The fiducial reading was taken immediately after immersing the denture in water for one half hour just subsequent to cast removal; the final reading was taken at 18 months in water or in service. For example, if a denture expanded or shrank proportionally over the molar-to-molar and the flange-to-flange distances, its warpage index would be zero. However, if it expanded molar-to-molar and shrank flange-to-flange, or if the shrinkage or expansion over the two distances were greatly out of proportion, the warpage index would be relatively high.

The warpage index for 48 technic and 70 clinical dentures is given in Table 2 with a range from 0.00 per cent for six dentures to 0.61 per cent for one lower clinical denture of Epoxolon, which expanded 0.99 per cent molar-to-molar and 1.60 per cent flange-to-flange. Even this warped denture continued to fit and function in a satisfactory manner and the patient was unaware of any change. The data in Table 2 show that most of the clinical dentures had slightly larger warpage indices than the technic dentures made of the same material. The widest variations in warpage index between the highest value for technic and clinical dentures of a particular base material were noted for Acralite 88 and pink vulcanite, which have lower stiffness and transverse strength than the others and for the Epoxolon dentures which have a large expansion. Even these differences were small. The warpage index comparisons (Table 2) do not indicate any significant superiority in the dimensional stability of the dentures made from any of the 12 base materials tests. The average warpage index for the 48 technic dentures was 0.07 per cent and for 70 clinical dentures it was 0.12 per cent. These differences are far too small to have any significance practically. Here again the technic dentures predicted the approximate behavior of the clinical dentures.

Relationship between the fit of clinical dentures on the gypsum casts on which they were cured and changes in molar-to-molar and flange-to-flange distances.

Figure 7 shows clinical upper dentures which were 24 months old seated on the gypsum casts on which they were cured. Denture A, made of a self-curing acrylic resin, had very low molar-to-molar (0.03%) and flange-to-flange (0.06%) expansion. Consequently, Denture A fits the cast remarkably well. Denture B, made of a heat-curing acrylic resin, had low molar-to-molar (0.18%) and flange-to-flange (0.11%) shrinkages. The degree of fit is only slightly less than in Denture A. In Denture C, made of an epoxy resin, the gross expansions (molar-to-molar, 1.5%, and flange-to-flange, 1.24%) are reflected in the poor fit of the denture on its cast.

Some of the minute discrepancies in fit shown in Dentures A and B (Figure 7) occurred during processing and polishing before the patients had the dentures. In contrast, practically all of the dimensional changes occurring in Denture C came while the denture was in use. Denture C continued to fit the mouth well because the very large expansion occurred slowly; thus the tissues were able to adapt. The refitting of a denture on its original gypsum cast shows whether some dimensional change or warpage occurred.

The examples of the fit of upper dentures (Fugure 7) are typical of the 14 uppers where the casts on which they were processed could be recovered. The original casts of nine clinical lowers, which had dimensional discrepancies similar to those of the uppers, were recovered. These lower dentures usually fit their casts better than the uppers after 24 months of service.

The correlation between dimensional changes in upper dentures and their relative fit on the cast on which they were processed confirms previous work[6,14].

If the fit of the denture on the cast on which it was processed is not as accurate as that shown by Denture B (Figure 7) one should look for errors in technic or faults in the resin base.

Pressure-indicator paste patterns. As stated previously, all patients were recalled in 1958, after the dentures had given several months of comfortable service. The new dentures and the old dentures which the patients had worn previously and which the authors had retained, were wiped dry, coated with a thin layer of a pressure-indicator paste*, sprayed with an emulsion furnished with the paste, inserted under heavy manual pressure, removed and photographed. In all instances, the new dentures showed a more uniform contact with the oral tissues than the old dentures. Typical patterns of the variation in contact with the tissues are shown in Figure 8. There was no relationship between the type of resin or method of processing and the patterns. There was a definite correlation between the fit of the new and the old dentures and the pressure-indicator paste patterns of the new and old dentures. In some instances this test revealed discrepancies in the fit of the new dentures that neither the patient nor the dentist had been aware of. Adjustments on these dentures were made by removing a thin film of resin from the area or areas of heavy content. Such a recall system might be advisable periodically for all denture-wearing patients.

*Mizzy Pressure Indicator Paste

3.2 Breakage

Out of 73 clinical dentures three were broken. Figure 9A shows a crack in a Jectron upper denture that was opposed by lower natural teeth. The crack developed in use after fifteen months. Denture B in Figure 9 was also opposed by natural teeth. According to the patient the disto-buccal flange was broken off this denture, made of Vernonite (powder-liquid type), when the patient bit on a piece of hard caramel candy which was lodged between the natural lower third molar and the buccal flange of the upper denture. This denture was 23 months old when the break happened. Another upper denture of Vernonite, also opposed by natural teeth, was fractured when the patient was struck in the mouth.

Out of the 44 upper clinical dentures, 14 are opposed by natural teeth.

3.3 Loss of teeth

No teeth came out of any of the dentures except those made of Epoxolon. After only 15 months, the eight clincal dentures of Epoxolon had lost 31 porcelain posterior teeth. The posterior teeth came out of the dentures because of a crevice developed around them (A in Figure 10). The crevices also occurred around the anterior teeth (B in Figure 10) but none were lost during the first 15 months, probably because of the additional retention furnished by the metal pins in the anterior teeth. The crevices developed as the dentures swelled in contact with the saliva. Naturally, the crevices, coupled with the porosity (A and B in Figure 10), made the dentures very unhygienic.

3.4 Staining, color instability, and roughness of surface.

Clinical dentures of Epoxolon showed a marked tendency to collect quickly stains, such as lipstick and, particularly, tobacco stains. The patients complained that these dentures were more difficult to keep clean than their previous dentures. The tendency of Epoxolon dentures to stain rapidly and easily is vividly shown in Figure 11. Here A is a heat-curing acrylic resin denture that the patient had worn for eight years with no other treatment than cleaning at home. Denture B is an Epoxolon denture after one week's use by the same patient who formerly wore acrylic resin Denture A.

The clinical dentures made with a Jectron (polystyrene) base showed a slightly greater tendency to collect tobacco stain than those made of poly(methyl methacrylate), but this was not severe enough to be a deterrent to the use of the polystyrene. Dentures made with a poly(methyl methacrylate) base usually collected stain only in areas where the surface had not been polished properly or in conjunction with a deposition of calculus, whereas those of the polystyrene base collected some stain, even on highly polished areas.

Epoxolon was the only denture base resin, among the 12 types used, that did not comply with the color stability test of American Dental Association Specification No. 12 for Denture Base Resin. Likewise the clinical dentures of Epoxolon were the only ones that were not color stable in use (D in Figure 11). This presents another example of the unusual validity of the color stability test in the specification.

Dentures made of Mystic 100, an acrylic resin denture base which contained 21 per cent by weight of glass fibers, had a rough surface on molding. The tissue side could not be polished, and its roughness appeared to irritate the tissues to such an extent in 15 months that new dentures with a different base were made for the patient. The tongue side could not be polished to a smooth surface as the glass fibers shelled out of the surface and left rough depressions which collected stain. For these reasons, only the one set of clinical dentures were made of Mystic 100.

4. SUMMARY

Changes in 73 clinical dentures and in 48 technic dentures stored in water were observed periodically for 18 months by: (1) measuring molar-to-molar and flange-to-flange changes across the posterior section, (2) taking pressure-indicator paste patterns of the tissue-borne surfaces, (3) checking the fit of the denture on the cast and in the mouth, (4) observing breakage, loss of teeth, staining and color stability.

These dentures were made with eight different acrylic resins, a polystyrene, a vinyl-acrylic copolymer, an epoxy resin and vulcanite.

All of the dentures expanded during the 18 months in service or in water except the vinyl-acrylic copolymer and vulcanite which shrank on the average

0.10 and 0.15 per cent over the molar-to-molar dimension. The average expansion of the other materials ranged from 0.02 per cent for a glass-fiber-filled acrylic resin to 1.01 per cent for an epoxy resin. After applying a temperature correction for mouth condition the average molar-to-molar dimension at the end of 18 months ranged from 0.50 per cent smaller (glass-fiber-filled acrylic resin) to 0.94 per cent larger (epoxy resin) than the average molar-to-molar dimension of the cured denture in the flask (Table 1). Two heat-cured compression molded acrylic resins were less than 0.10 per cent smaller and approached the ideal of zero per cent change. Regardless of these changes neither the dentist nor the patient could observe any difference in the relative fit of the dentures.

After two or three months in use or in water all of the bases except the epoxy resin were stable in dimension and changed very little with time; there appeared to be no advantage among the various bases tested in regard to dimensional change with the exception of the high expansion of the epoxy resin; vulcanite had no advantage as far as dimensional stability is concerned;

and the expansion caused by water sorption did not compensate for the shrinkage during processing, except in the epoxy resin which expanded far too much and for the self-curing acrylic resin which slightly over-compensated.

Sixteen other dentures made of heat-cured and self-cured acrylic resins were available to the authors for measurement after six years in use. The largest flange-to-flange changes in any of these dentures were not more than 0.5 mm. or about 0.08 mm. annually. None of the changes caused any adverse effects on the fit and serviceability of these dentures.

A comparison of the dimensional stability of technic dentures stored in water with clinical dentures made of the same materials showed only little differences which would not have any clinical significance.

The warpage index (the difference in the molar-to-molar and flange-to-flange changes in percentage was greatest for the epoxy resin, 0.30 per cent, and lowest for the polystyrene and glass-fiber-filled acrylic resin, 0.02 per cent. None of the warpage could be detected clinically.

The dimensional changes across the posterior portion of the dentures were reflected in the fit of the dentures on the gypsum casts on which they were processed. If there were serious misfits, one should look for errors in processing or for a faulty resin base.

Pressure-indicator paste patterns of new dentures after several months of use showed there was a more uniform contact with the tissue than did the patterns made in the old dentures which the patient had worn previously. The patterns revealed discrepancies in the fit of new dentures that would not have been detected otherwise.

Three out of 73 clinical dentures broke. All were uppers opposed by natural teeth. One fracture of an acrylic resin denture was caused by a blow. In another acrylic resin denture the buccal flange was broken off in chewing. There was a typical mid-line fracture in one polystyrene denture.

The epoxy resin dentures stained badly and quickly lost teeth, were difficult to keep clean because of porosity and of crevices that developed around the teeth, and were not color stable. These defects, combined with the high rate of expansion that had not leveled off after two years of service, showed that this epoxy resin is not satisfactory as a denture base material.

All clinical dentures functioned well except those made of an epoxy resin and a heavily glass-fiber-filled acrylic resin.

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TABLE 1

RELATIONSHIP BETWEEN AVERAGE CURING SHRINKAGE AND AVERAGE MOLAR-TO-MOLAR CHANGE IN UPPER AND LOWER DENTURES STORED IN WATER OR IN USE

Denture base	Number of Dentures	Curing change(1)	Change in water or in service in 18 months(2)	Total changes(3)	Temperature correction(4)	After temperature correction(6)
		Per cent	Per cent	Per cent	Per cent	Per cent
Acralite 88	12	- 0.26	+ 0.30	+ 0.04	+ 0.14	+ 0.18
Duraflow	12	- 0.37	+ 0.23	- 0.14	+ 0.13	- 0.01
Epoxolon	12	- 0.15	+ 1.01	+ 0.86	+ 0.11	+ 0.97
Hydro-Cast	14	- 0.51	+ 0.25	- 0.26	+ 0.13	- 0.13
Jectron	12	- 0.41	+ 0.03	- 0.38	+ 0.10	- 0.28
Luxene 44	12	- 0.34	- 0.10	- 0.44	+ 0.10	- 0.34
Miracle 50	6	- 0.50	+ 0.08	- 0.42	+ 0.07	- 0.35
Mystic 100	6	- 0.58	+ 0.02	- 0.56	+ 0.06	- 0.50
Tilon	13	- 0.59	+ 0.30	- 0.29	+ 0.12	- 0.17
Vacalon	4	- 0.54	+ 0.22	- 0.32	+ 0.12(5)	- 0.20
Vernonite P/L	12	- 0.40	+ 0.18	- 0.22	+ 0.15	- 0.07
Vulcanite (Hygienic dental rubber)	6	- 0.29	- 0.15	- 0.44	+ 0.08	- 0.36

(1) Molar-to-molar change from cured denture in flask through polishing and one day in water.

(2) The amount of gain (+) or loss (-) in molar-to-molar distance caused by storage in water (technic dentures) or in use (clinical dentures).

TABLE 1 (continued)

(3) Molar-to-molar change from cured denture in flask through 18 months storage in water or in use.

(4) The expansion of the dentures when heated from room temperature [22°C. (72°F.)], the temperature at which the molar-to-molar distances were measured, to mouth temperature [37°C. (98.6°F)], the temperature of the dentures when in use. The coefficients of thermal expansion used in the computation of these values were obtained from the Dental Research Section at the National Bureau of Standards.

(5) The coefficient of thermal expansion used in this computation was 83×10^{-6}, an estimated coefficient based upon other values for water saturated poly(methyl methacrylate) bases over the range [20° - 37°C. (68°- 98.6°F.)].

(6) The sum of (3) and (4) represents the average change in molar-to-molar distance from the cured denture in the flask at room temperature to the denture in use 18 months later at mouth temperature.

TABLE 2
WARPAGE INDEX AT THE END OF 18 MONTHS(1)

Base Material	Technic dentures					Clinical dentures									
	Uppers		Lowers			Uppers						Lowers			
	Thin	Thick	Thin	Thick	Avg.	1	2	3	4	5	Avg.	1	2	3	Avg.
	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
Acralite 88	0.00	0.05	0.05	0.04	0.04	0.05**	0.06*	0.37	0.04	0.59	0.22	0.09	0.05	0.09	0.08
Duraflow	.08	.02	.04	.02	.04	.13	.04	.15	.03	.22	.12	.00	.13	.07	.07
Epoxolon	.03	.06	.30	.04	.11	.13	.19	.28	.18	.51	.26	.22	.61	.07	.30
Hydro-Cast	.08	.05	.06	.03	.05	.01	.11	.11	.12	.04	.08	.03	.06	.15	.08
Jectron	.11	.12	.07	.13	.11	.06	.00	.03	.06	.14	.06	.00	.07	.00	.02
Luxene 44	.03	.01	.06	.01	.03	.02	.01	.11	.01	.05	.04	.09	.01	.12	.07
Miracle 50	.04	.01	.04	.06	.04	.05					.05	.02			.02
Mystic 100	.10	.17	.10	.00	.09	.06					.06	.21			.21
Tilon	.12	.19	.13	.22	.16	.23	.11	.27	.01	.29	.18	.06	.04	.15	.08
Vacalon	*.07	.09	*.02	.13	.08										
Vernonite P/L	.06	.02	.01	.07	.04	.19	.18	.04	.01	.19	.12	.05	.11	.11	.09
Vulcanite	*.04	.12	*.14	.08	.09	.37					.37	.19			.19
Average	% (0.07)		% (0.08)					% (0.14)					% (0.10)		

* 12-month value
** 9-month value
(1) Difference in per cent change between the molar-to-molar and flange-to-flange measurements.

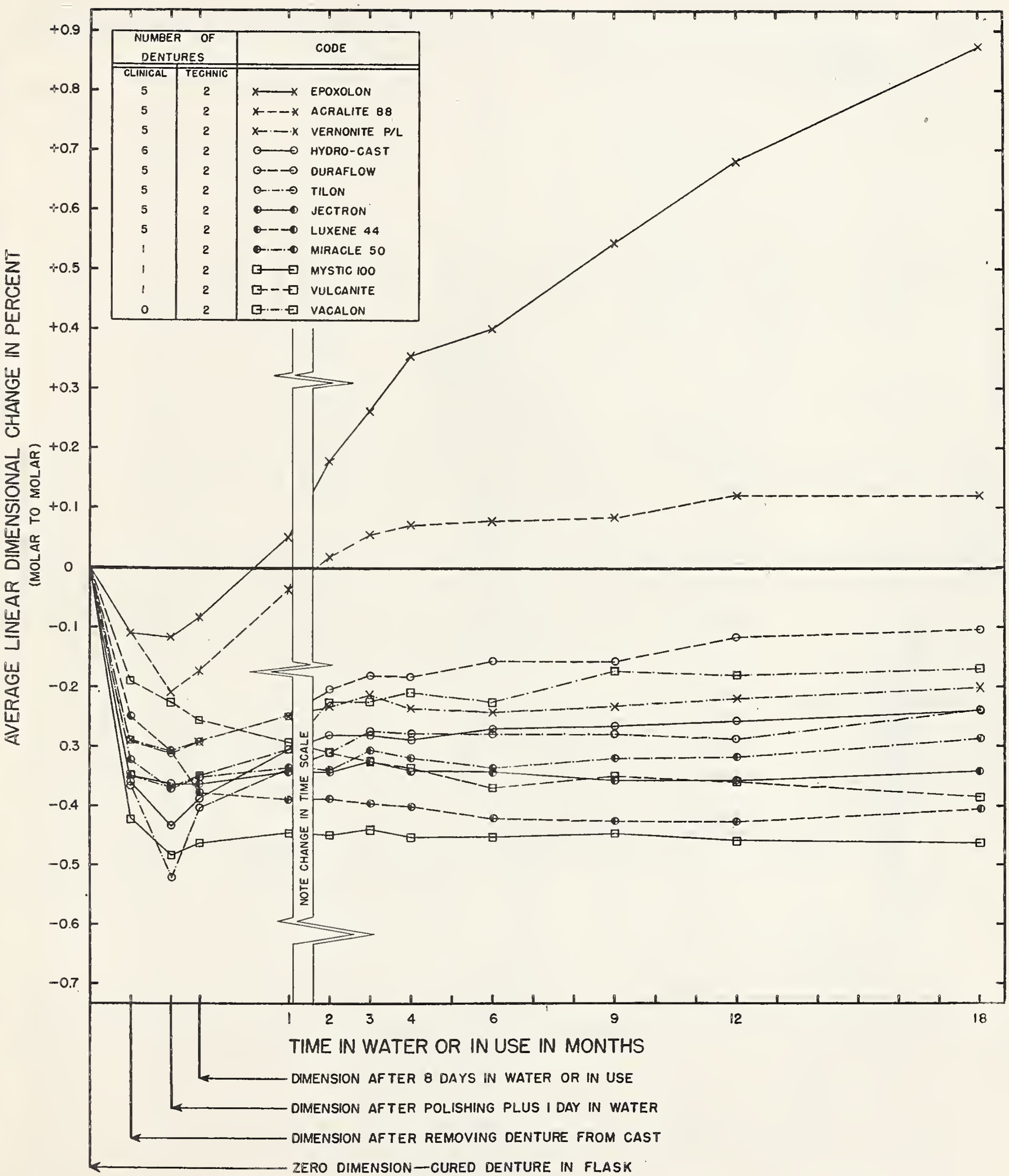

Figure 1. Average molar-to-molar change in clinical and technic upper dentures.

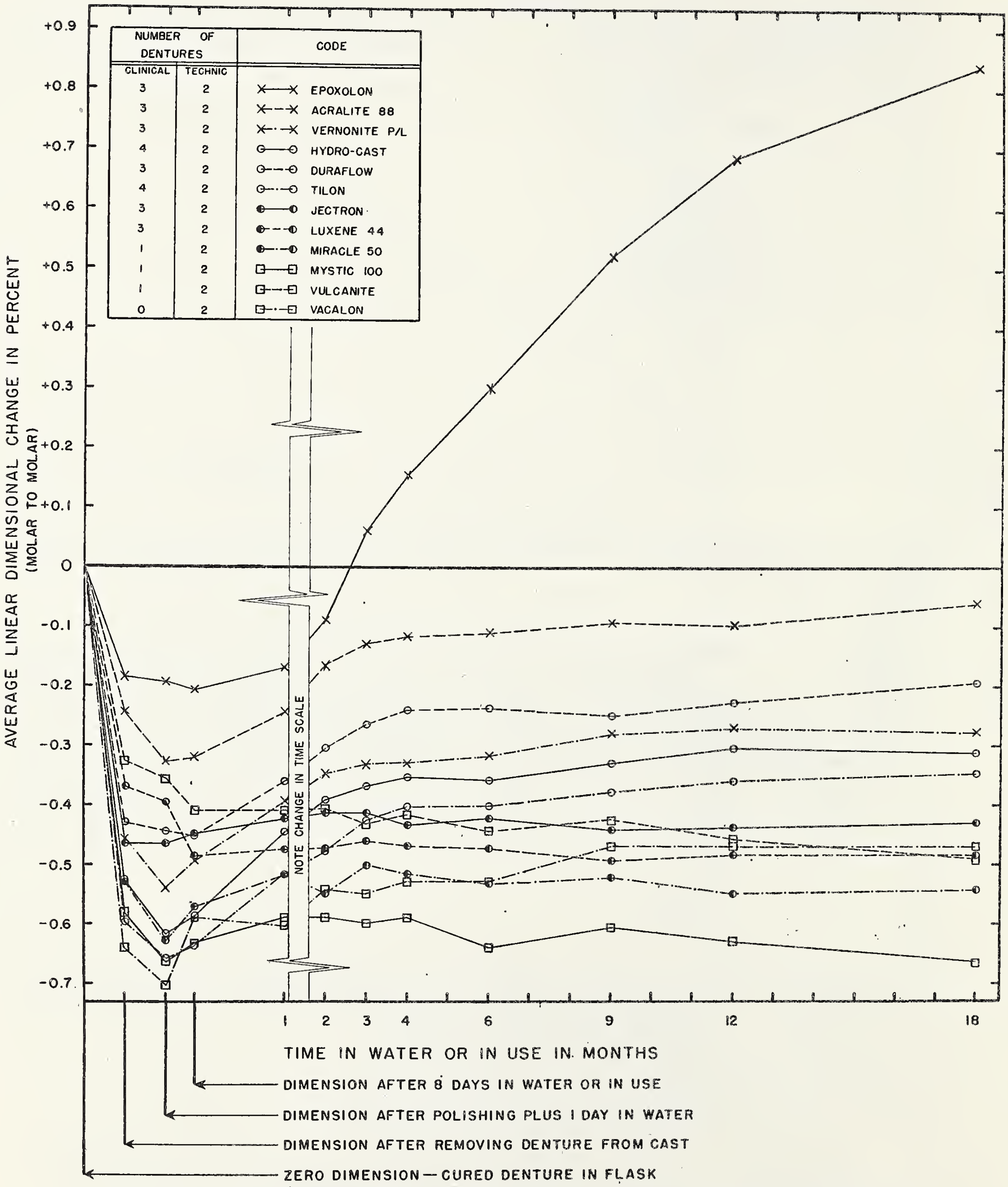

Figure 2. Average molar-to-molar change in clinical and technic lower dentures.

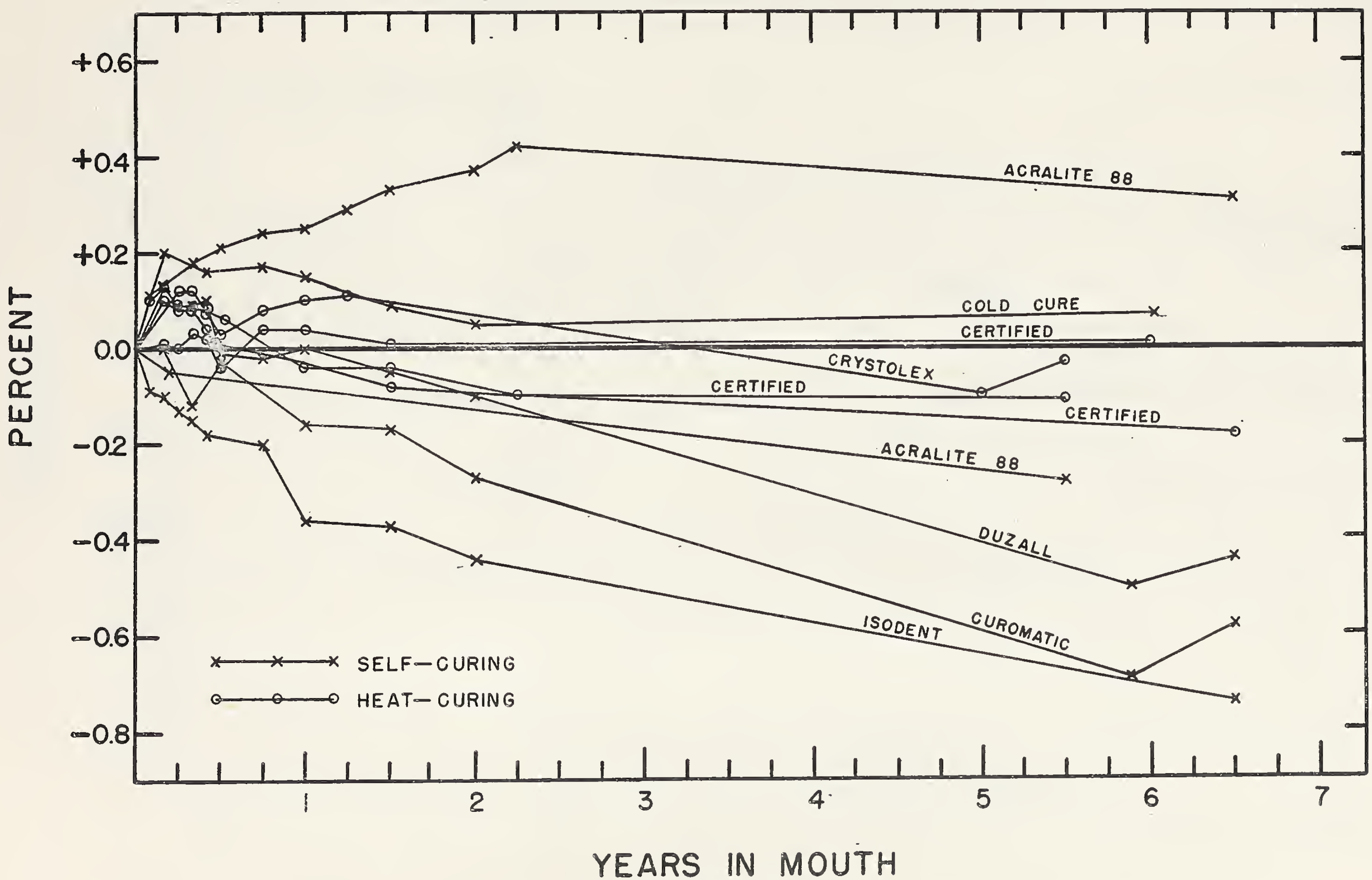

Figure 3. Flange-to-flange changes in self-curing and heat-curing upper dentures.

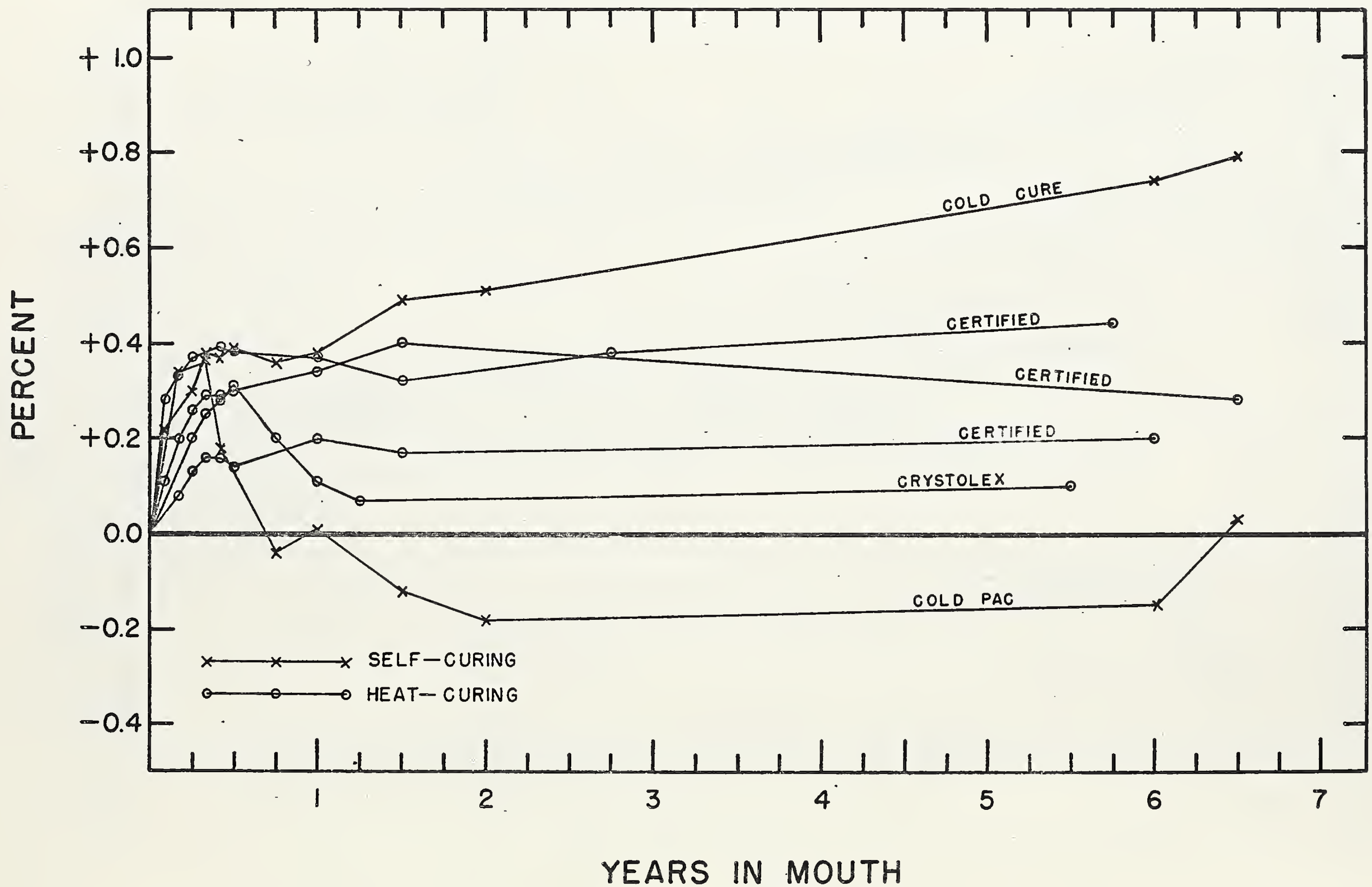

Figure 4. Flange-to-flange changes in self-curing and heat-curing lower dentures.

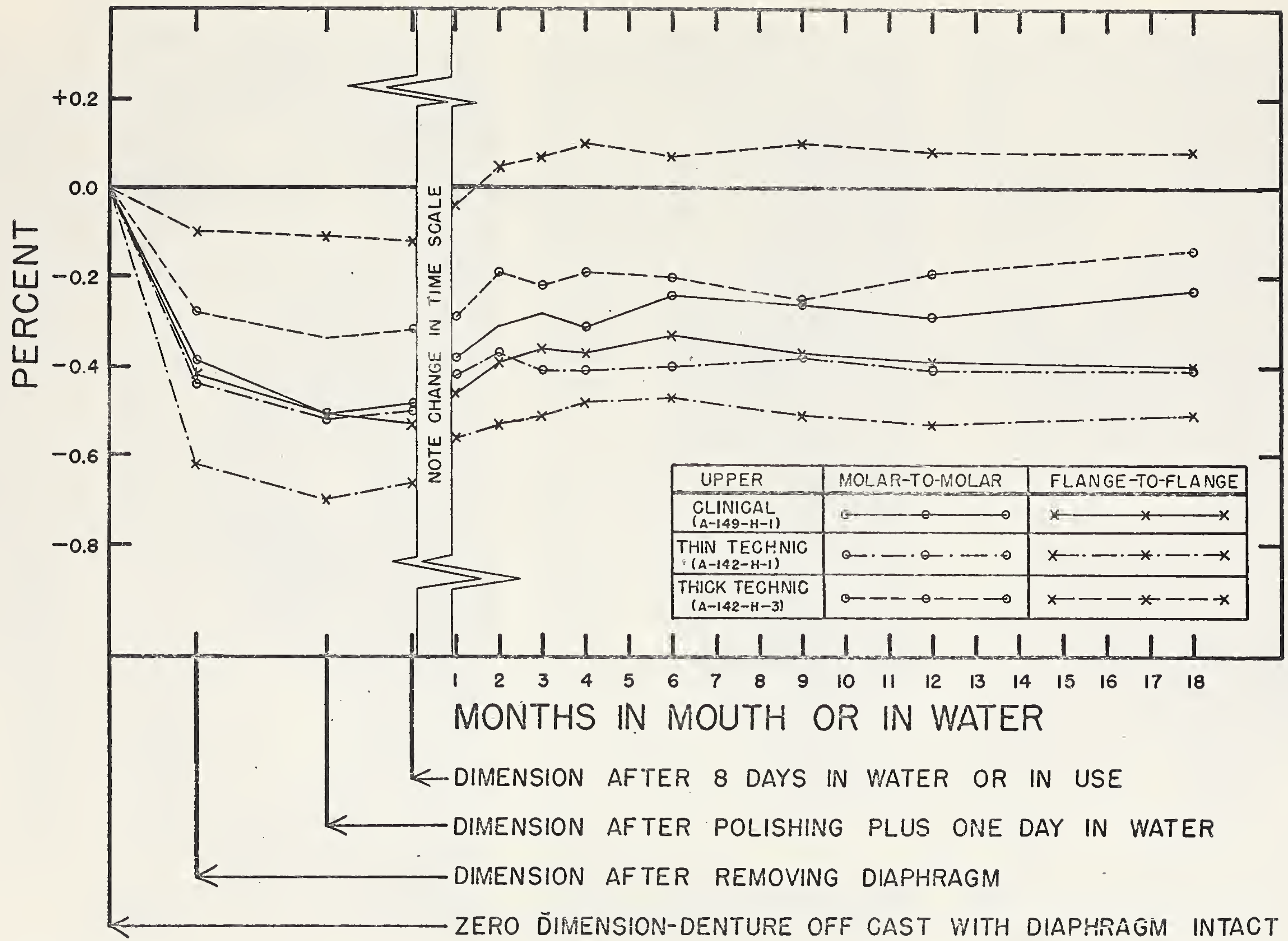

Figure 5. Comparison of linear change in technic and clinical dentures (Hydro-Cast).

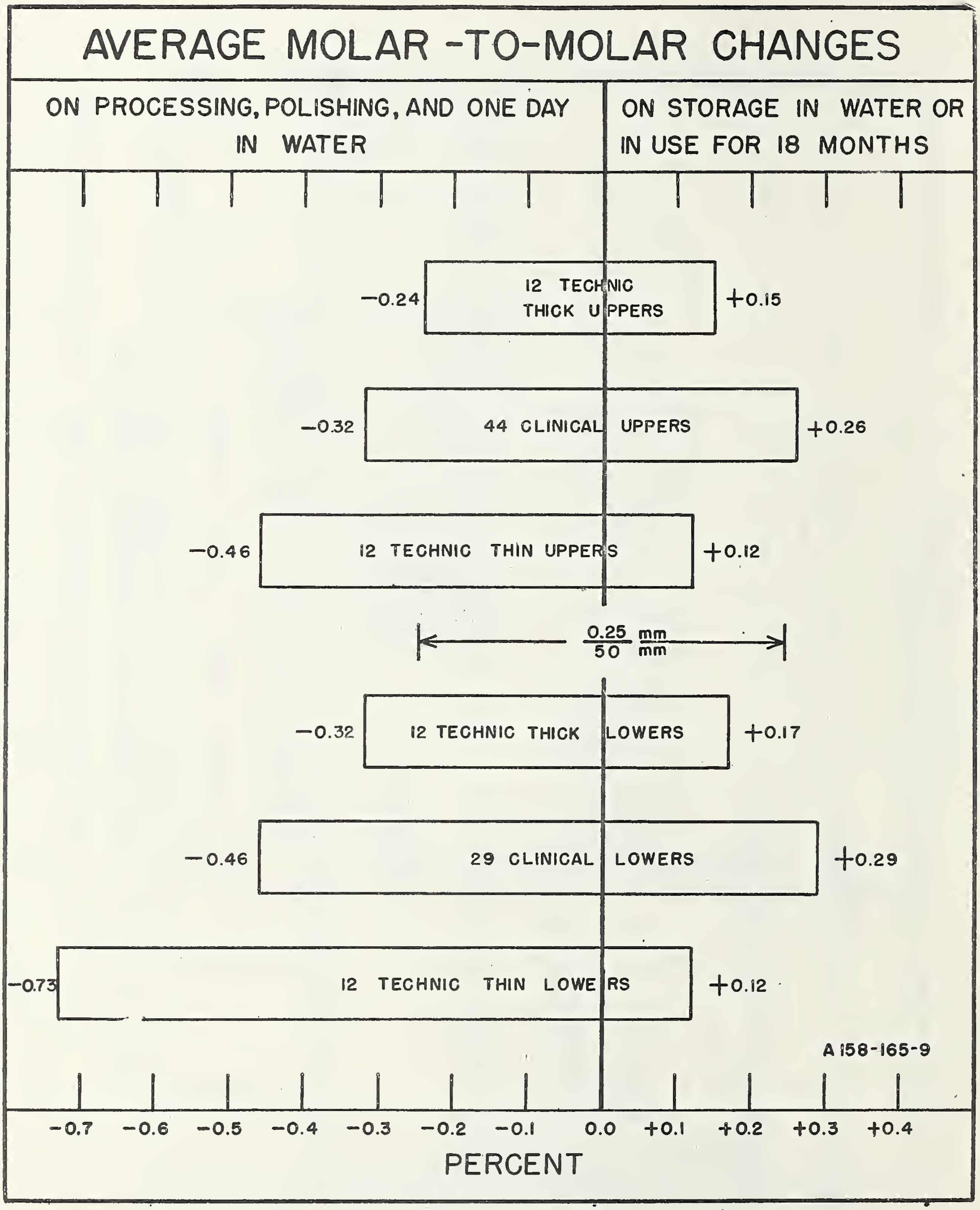

Figure 6. Relationship of bulk and shape of dentures to the average linear changes during processing, during storage in water, and in use.

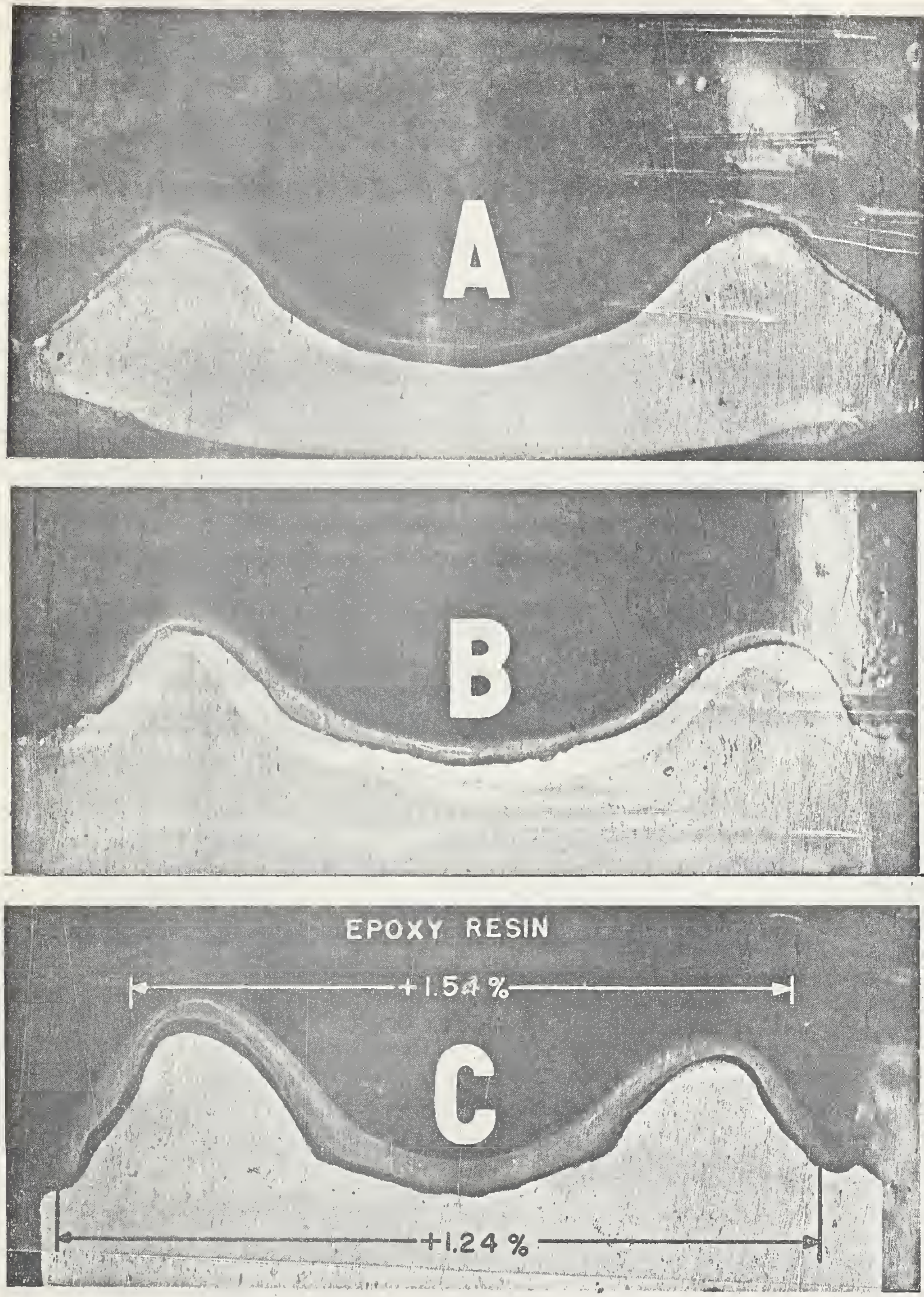

Figure 7. Relationship between the fit of upper clinical dentures on the gypsum casts on which they were cured and changes in molar-to-molar and flange-to-flange distances. All of the end measurements were obtained after twenty-four months in service. The fiducial measurements were made with the deflasked dentures on the cast except in the flange-to-flange measurement on denture A. Here the fiducial measurement was made on the denture removed from the cast.

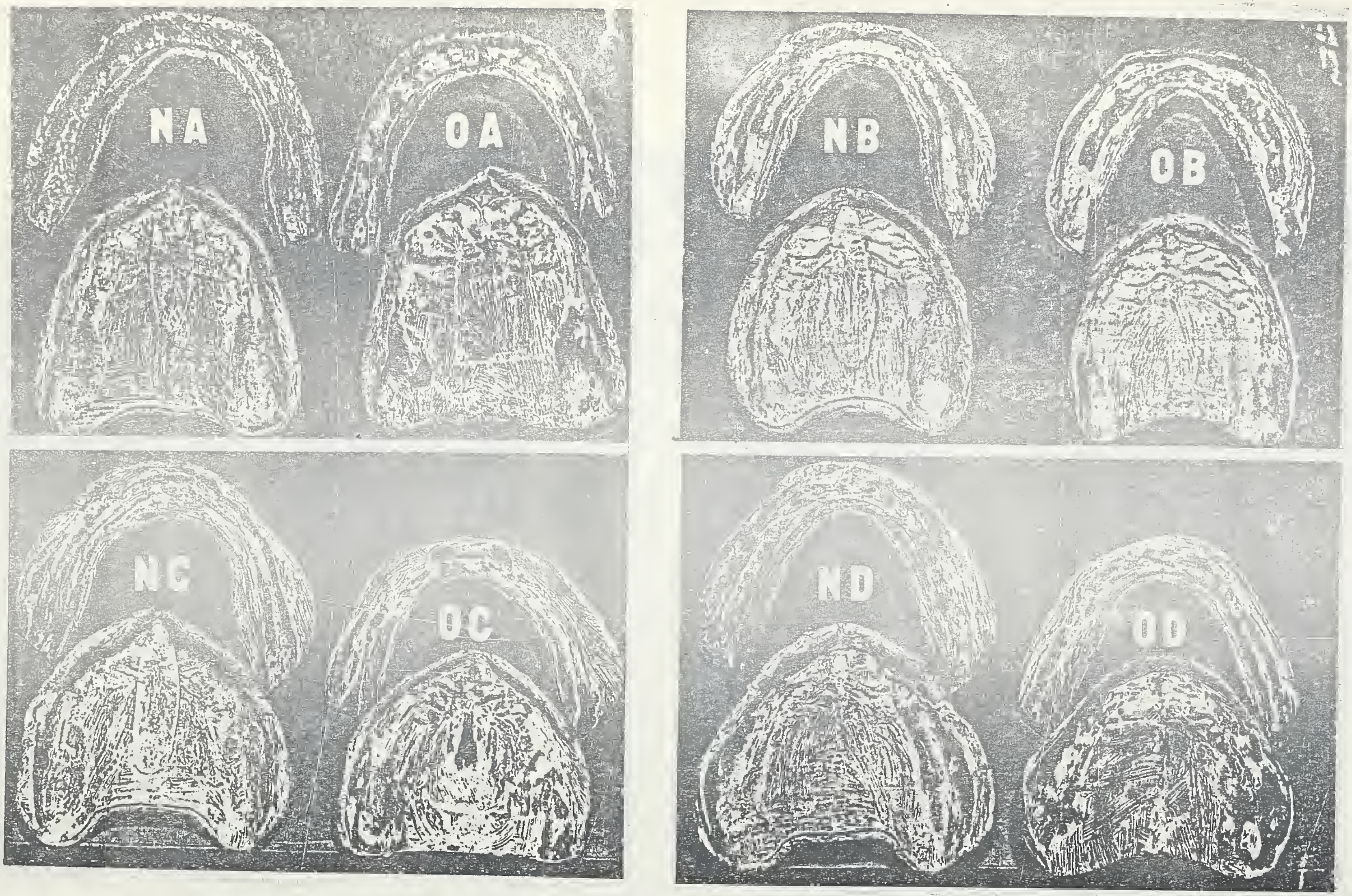

Figure 8. Pressure indicator paste patterns of new (NA, NB, NC and ND) dentures and old (OA, OB, OC and OD) dentures. The new dentures are made of compression-molded acrylic resin (NA): an epoxy type of resin (NB): an injection-molded acrylic resin (NC): and a polystyrene (ND). All of the old dentures appeared to be acrylic resin except the upper OD which was vulcanite. The dark areas show evidence of heavy contact. In the old upper dentures bilateral heavy contact was found, with few exceptions, on the posterior part of the ridge, especially the crest of the ridge near the tuberosity. In the old lower dentures the areas of heavy contact were usually bilateral and mostly on the crest of the ridge.

There are also some areas of heavy contact on the

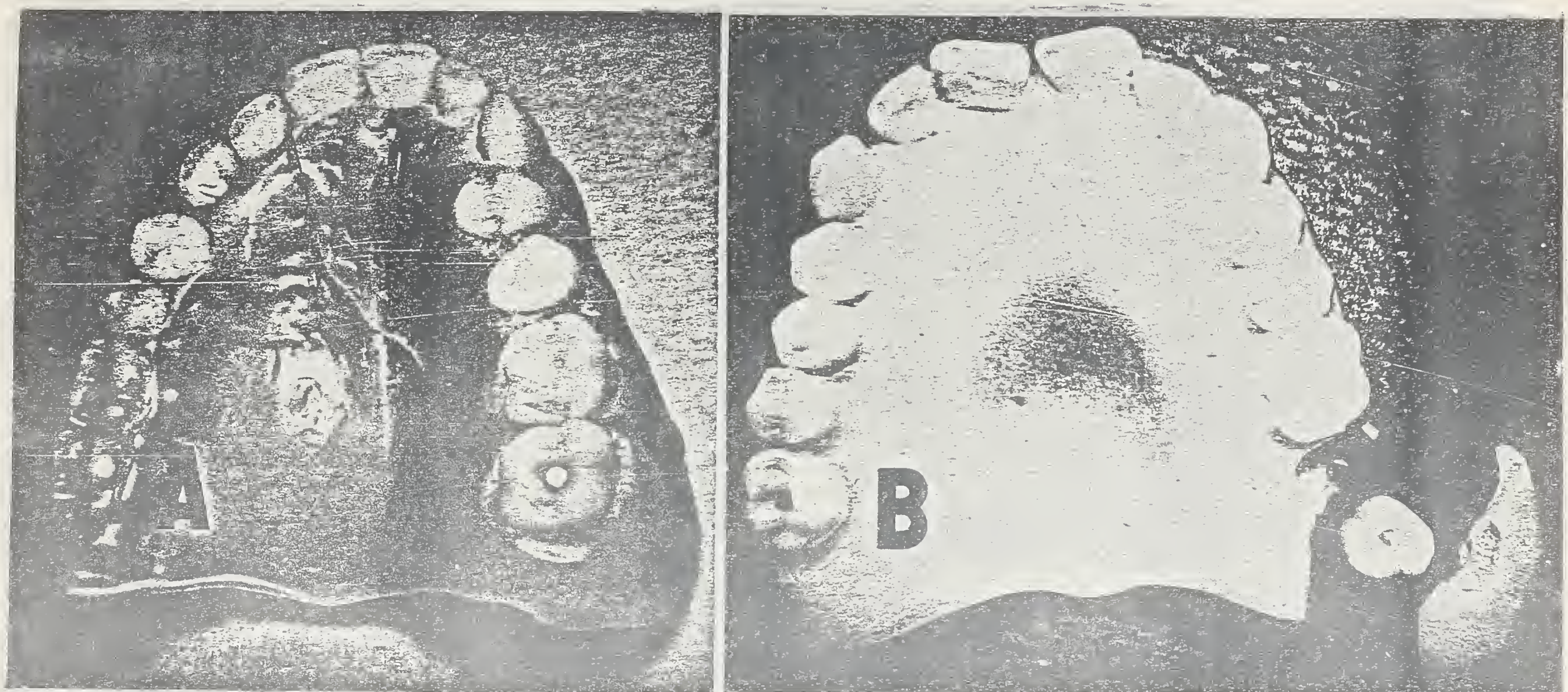

Figure 9. Shown in A is a typical midline fracture in a Jectron upper denture opposed by natural teeth. This crack extending through the labial flange developed after 15 months of use. In B a fracture that occurred in a Vernonite (powder-liquid type) upper denture opposed by natural teeth. This broke when the patient bit on a piece of hard caramel candy which lodged between the natural lower third molar and the buccal flange of the upper denture. Denture B had been in service 23 months when the break occurred.

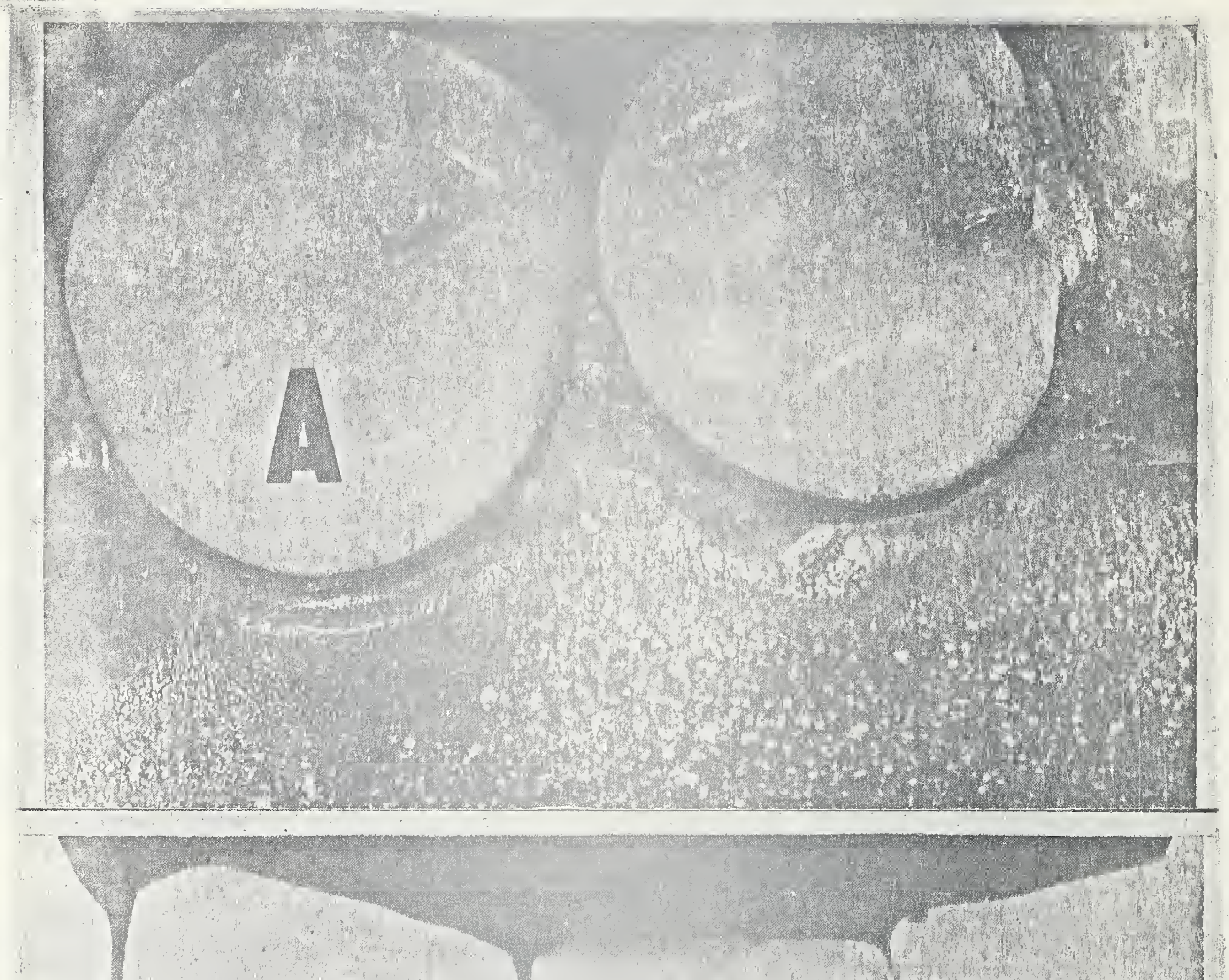

Figure 10. Epoxolon dentures showing separation of teeth from the base resin. Upper denture A and lower denture B were in service 17 months when the two left upper molar teeth were lost. Spaces observed around the bicuspids (A) and the anterior teeth (B) were caused by expansion of the functioning epoxy resin denture in contact with saliva. No molding pressure was used in packing or curing so the porosity evident in (A) and (B) frequently occurred in the areas of thick cross-section.

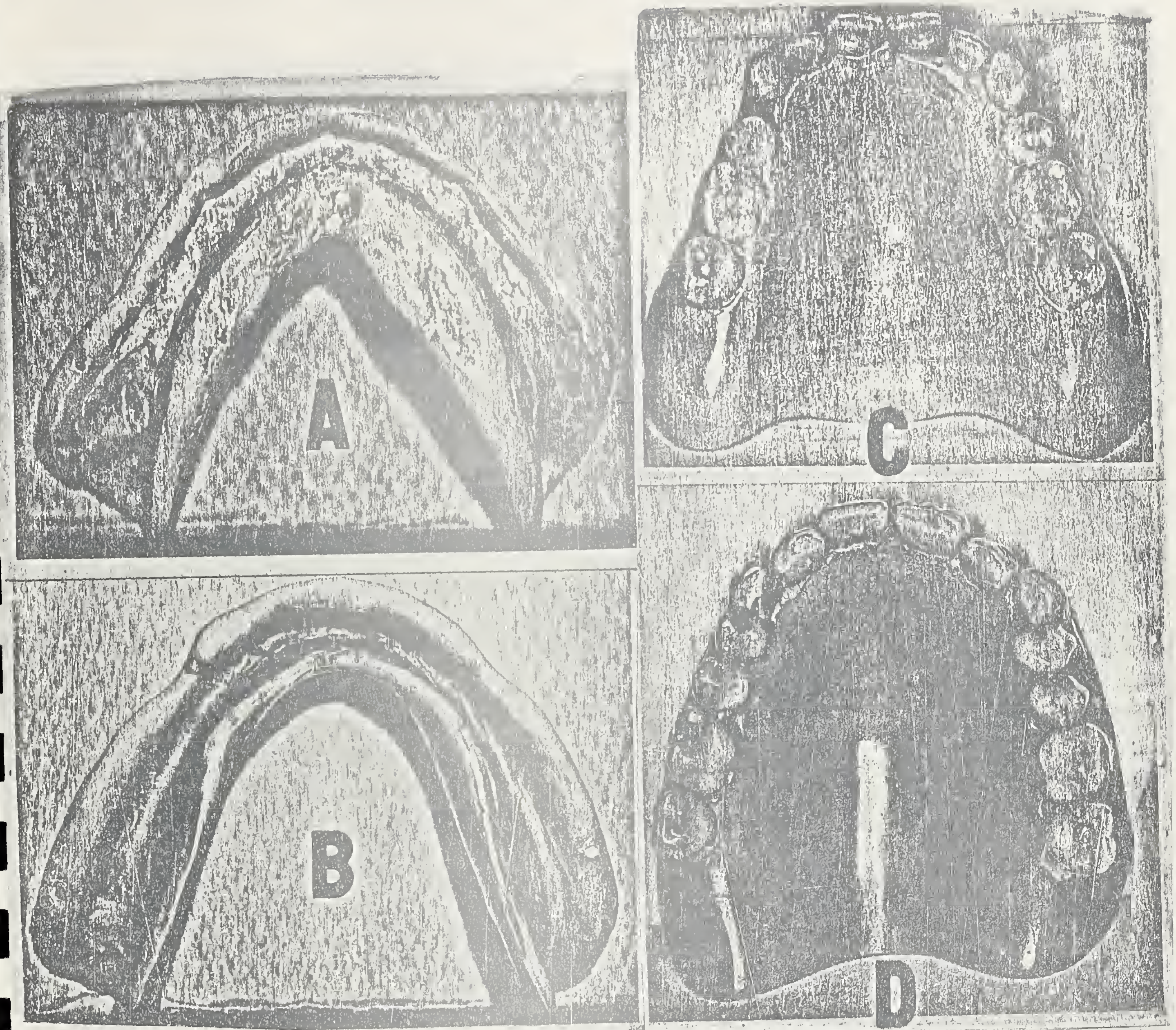

Figure 11. The staining and color instability of Epoxolon dentures.
Denture A, made of a heat-curing acrylic resin, had been worn by the patient for eight years. Only slight staining and calculus deposits are present. Denture B, made of Epoxolon for the same patient, shows the unusual amount of staining that occurred in one week's use. Most of the stain on all of the dentures appeared to be tobacco tar.
The Epoxolon dentures shift from tissue pink to an organge tint both in the lamp test for color stability described in the American Dental Association Specification No. 12 for Denture Base Resins, and in actual use (D).
Denture (C) was made of heat-cured acrylic resin that had been in service for 28 months and was not repolished. Denture (D) was made of Epoxolon and was repolished after 29 months of service. The color of the Epoxolon denture (D) at the time it was given to the patient was approximately the same as that of the heat-cured acrylic resin (C) used in this comparison.