The softness and initial flow of temporary soft lining materials

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The initial flow of four temporary soft lining materials was studied with a simple laboratory test procedure, using a parallel-plate plastimeter. The flow in a clinical situation was further investigated, together with a clinical assessment of softness. The results indicate that a 2-mm thickness of temporary soft lining material is considered suitable for use as a tissue conditioner. The thickness of lining material is influenced by the clinical technique and by the powder to liquid ratio; however, the scope for altering the ratio is limited. □ *Physics; powder to liquid ratio; removable prosthetics*

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Temporary soft lining materials have been widely used in several clinical situations. Apart from their role as tissue conditioners, a role McCarthy & Moser (1) more aptly described as 'reconditioning of abused tissues', these materials have also been found to be useful in taking functional impressions (2–4), in shaping cleft-palate obturators, in the aftercare of immediate dentures (5, 6), and in combination with antifungal agents to inhibit the growth of *Candida albicans* (7).

Despite their widespread use, comparatively little research has been undertaken on quantifying the clinical requirements and behavior of temporary soft lining materials. There is general agreement on some of the desirable properties of these materials when used as tissue conditioners; Wilson et al. (8) stressed the importance of softness and elasticity. When using the materials for functional impression, however, the same authors stressed the importance of plastic flow. Other reports, both clinical (9) and laboratory-based (10, 11), have shown that these materials are able to produce accurate impressions of the oral tissues. One report (11) emphasized the importance of the material being at least 2 mm thick so as to ensure accuracy.

It would seem advisable that a standard specification for temporary soft lining materials be developed, and it would seem appropriate that two important clinical requirements, initial flow and softness, should be included in a specification. If realistic specification limits are to be set, it is important that the values are related to the views of clinicians who have been using the materials routinely.

The purpose of this paper is to report on three aspects: 1) an examination of the initial flow of temporary soft lining materials, using a simple test procedure; 2) clinical acceptability of flow; and 3) clinical acceptability of softness.

From these results it should be possible to suggest ways in which these materials can be used to better advantage. Knowing the mixes of materials that find wide clinical acceptance, it should be possible to apply other tests to these mixes to produce realistic standard specification limits.

Materials and methods

Initial flow

We investigated four temporary soft lining materials; the powder to liquid ratios were

Table 1. The four temporary soft lining materials investigated

Material	Manufacturer's powder to liquid ratio by weight	Batch no.
Coe-comfort	1:1	P101883A
G.C.'s soft liner	1.2:1	120431
Ivoseal (thick consistency)	1.75:1	Powder 27143 Liquid 9532 cu.
Ivoseal (thin consistency)	1.6:1	
Viscogel	1.4:1	DD117DE67 84/06

in accordance with the respective manufacturers' instructions (Table 1).

To assess the initial flow, a 2-cm^3 sample of each material was compressed between the two glass plates of a parallel-plate plastimeter (Fig. 1). The weight of the upper plate (the minor load) was 100 ± 1 g, and its thickness was not less than 2.0 mm. A major load of 1000 *g* could be applied at an appropriate time. The apparatus is described fully in ISO Standard 1563. The volume of each sample was dispensed by means of a disposable syringe with an internal diameter of approximately 1 cm. Care was taken to ensure that both minor and major loads were applied vertically and without rotation. To try to simulate the clinical situation, the two loads were applied to each sample of material in an attempt to reproduce: a) the load exerted clinically on the soft material when the denture is seated initially and the patient comes into the lightest contact—that is, the minor load; and b) the load exerted clinically when the teeth are brought more firmly into contact—that is, the major load.

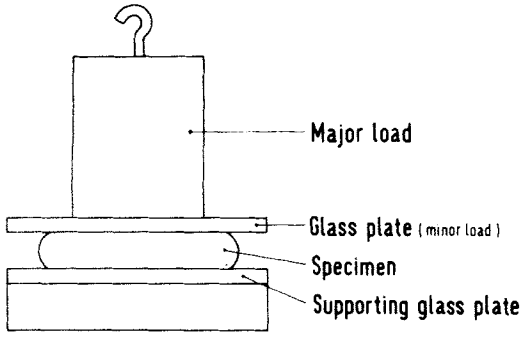

Fig. 1. The parallel-plate plastimeter.

The minor load was applied 30 sec after the completion of mixing, and the plastimeter assembly was immediately transferred to an oven at 37°C. In three separate experiments the major load was applied at 60, 120, and 240 sec after the end of mixing, the duration of application being 60 sec. After removal of the major load, the minor load was left in place until 5 min had elapsed after the completion of mixing. The plastimeter was then removed from the oven and the maximum and the minimum diameters of the resulting disc measured with a Jocal digital caliper (C. E. Johansson, Sweden). The recorded diameter was taken as the mean of the two readings.

We believed that the determination of the mean thickness, a major influencing factor on functional softness, which would occur under a denture was of particular clinical significance. Thickness was therefore calculated by means of the formula:

$$t = \frac{v}{\pi r^2},$$

where t denotes the thickness of the specimen, v the volume of the material dispensed, and r the radius of the specimen.

Clinical assessment of flow

To relate the results of the parallel-plate plastimeter experiments to the clinical environment, the two materials with the least and the most flow according to the present initial flow test, Ivoseal and Viscogel, were investigated more closely to determine by how much the powder to liquid ratios of these materials could be altered and still produce a clinically acceptable soft lining.

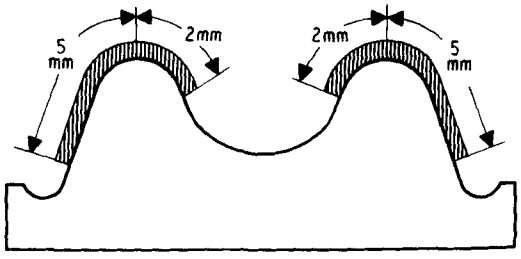

Fig. 2. Proportions of the channel incorporated into a maxillary denture.

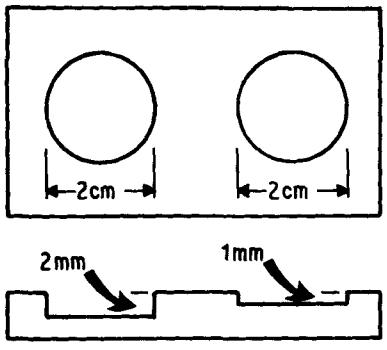

Fig. 3. Diagram representing the acrylic block used to test the softness of Ivoseal and Viscogel.

The mixes investigated were: 1) manufacturer's recommendation; 2) an increase of powder by 50%; 3) a reduction of powder by 50%; 4) an increase of powder by 100%; and 5) a reduction of powder by 75%.

The clinical flow was tested by applying a standard volume of the test mixture (3 ml) in the fitting surface of a maxillary complete denture processed on a model on which a relief had been incorporated along the alveolar ridge. The proportions of the channel so formed in the denture are shown in Fig. 2 and are intended to represent a denture that has ceased to fit accurately because of ridge resorption. The denture with the temporary soft lining material was placed in the mouth with 'standard clinical techniques', and the patient was asked to close gently into occlusion. The clinical techniques ensured that the seating pressure did not cause any pain or unduly compress the mucosa.

After initial setting had occurred, the denture was removed, and the surface of the material examined visually under a standard dental operating lamp. Eight operators assessed each material and each mixture and were asked to report each test as being satisfactory or unsatisfactory. These operators were all qualified dentists with long experience in the field of prosthetic dentistry. The criteria for their evaluations were that a satisfactory material would cover the entire mucosal surface of the denture and also present a surface free from voids, wrinkles and/or major air inclusions (minor air bubbles were acceptable in low numbers). The parallel-plate plastimeter test was undertaken on mixtures that showed a reasonable level of acceptability.

Clinical assessment of softness

The clinical acceptability of the softness of temporary soft lining materials was tested by using the same two materials, Ivoseal and Viscogel, as used for the flow test. Only two mixtures were investigated for Ivoseal, the manufacturer's recommended mixture (which was also the least fluid acceptable) and the mix with 50% less powder. In the case of Viscogel, powder contents of +50% and −50% of the recommended ratio were tested in addition to the manufacturer's recommendation. The test mixes were placed in two circular cavities cut into an acrylic block (Fig. 3). Fifteen minutes after the cavities were filled, the block was immersed in distilled water at 37°C, and the water changed at weekly intervals. To transport the specimens to the test venue, it was not practicable to maintain the storage temperature. Thus all specimens were held at room temperature for the last 24 h. For this section of the study it was decided to gauge clinical opinion on a wider scale. By means of a 2.5-mm-diameter smooth-ended amalgam condenser the specimens were tested by 40 clinicians who were asked to judge the suitability of the material for conditioning traumatized mucosa and then to record their opinion as satisfactory, too hard, or too soft. The 40 clinicians taking part in this aspect of the study were delegates

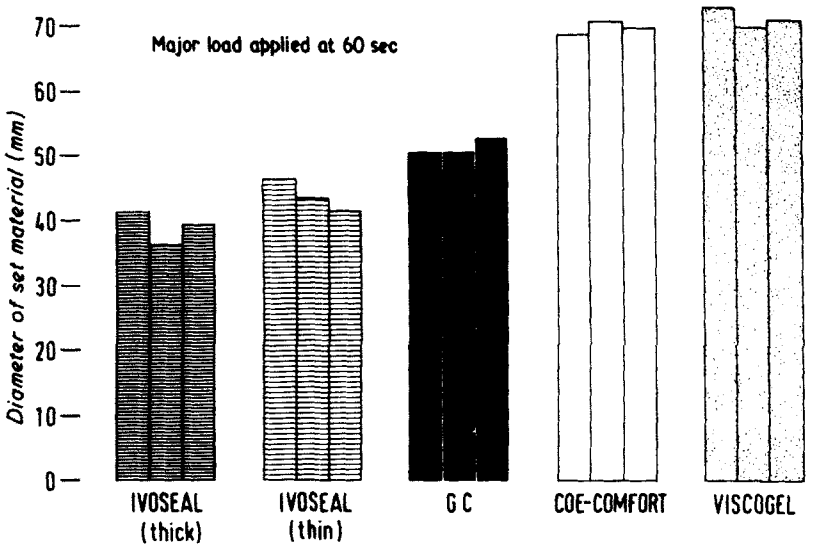

Fig. 4. Bar diagram illustrating the diameter of samples produced when the major load is applied at 60 sec. The three results for each material are replicate determinations.

attending the Annual Conference of the British Society for the Study of Prosthetic Dentistry in 1985. Specimens aged 1, 3, 7, and 28 days were tested.

Results and discussion

Initial flow

The diameter obtained by a given volume of material between the two plates of the plastimeter will depend on three factors: 1) the consistency of the material; 2) the magnitude of the load applied; and 3) the timing and duration of application of the load.

The results of the parallel-plate plastimeter tests for different loading times are shown in Figs. 4, 5, and 6. The three results for each material are replicate determinations. Each result is included in the figures to give an indication of scatter.

When the major load was applied 60 sec

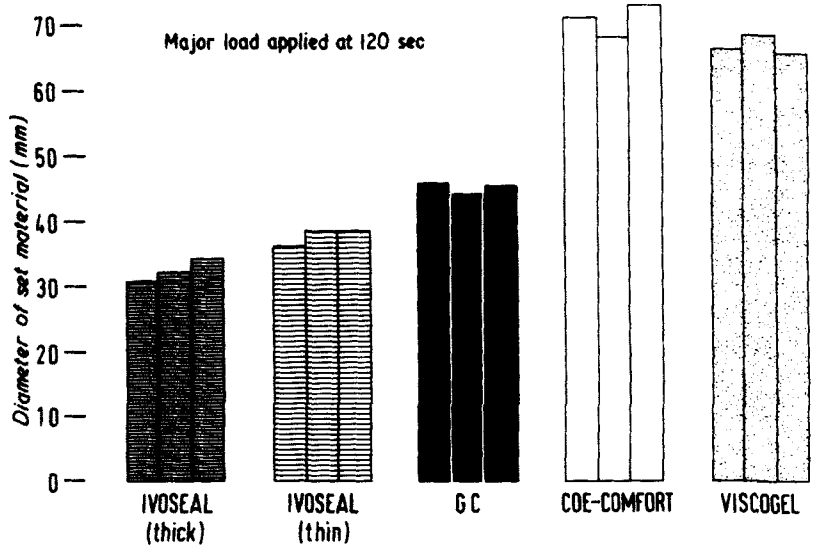

Fig. 5. Bar diagram illustrating the diameter of samples produced when the major load is applied at 120 sec. The three results for each material are replicate determinations.

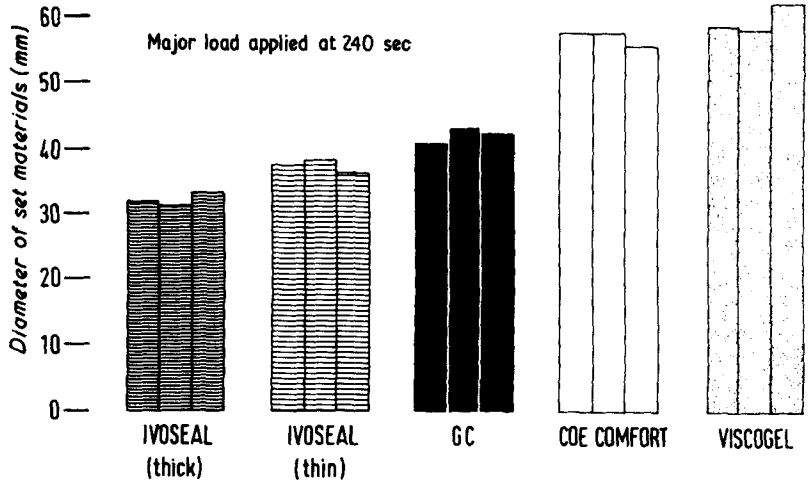

Fig. 6. Bar diagram illustrating the diameter of samples produced when the major load is applied at 240 sec. The three results for each material are replicate determinations.

after completion of mix (Fig. 4), the samples of Ivoseal produced the smallest diameters, Coe-comfort and Viscogel produced the largest, and G.C. soft liner occupied an intermediate position. A similar situation occurred when the major load was applied at 120 sec (Fig. 5); however, the diameters of the Ivoseal and G.C. soft liner samples were reduced, whereas the diameters of the Viscogel and Coe-comfort samples remained of the same order. This suggests that the first two materials had already reached an advanced state of set before the major load was applied at 120 sec and were therefore unlikely to show as much flow as previously. The Viscogel and Coe-comfort samples were still in a fluid state and showed the same degree of flow as previously.

When the major load was applied after 240 sec (Fig. 6), the Ivoseal and G.C. soft liner samples, not surprisingly, showed no further change. However, the mixtures of Viscogel and Coe-comfort had begun to set, and the samples of these materials therefore showed reduced diameters at this latest time of application.

The results for thickness are presented in Fig. 7, in which it can be seen that the values ranged from 0.5 mm to 2.5 mm depending on the material and time of application of the major load. The results indicate that, when the standard powder to liquid ratios recommended by the manufacturers were used, a thicker conditioning layer will only be produced if the patient's closing force is carefully controlled in terms of timing and magnitude. For the less viscous materials it is apparent that the patient must close together with the lightest possible contact as the material sets.

All the results for initial flow indicate trends of behavior and offer guidance to the clinician as to which material may be appropriate for a particular clinical situation.

Clinical assessment of flow

The two materials that exhibited the least and the most flow, Ivoseal and Viscogel, were tested further to determine the limits of clinical acceptability produced by varying the powder to liquid ratios. In the case of Viscogel (Table 2) it was possible to produce degrees of satisfaction with a powder content ranging from a reduction of 50% below that recommended by the manufacturer to an increase of 50% above the recommended amount. With Ivoseal, however, a 50% increase in powder produced too stiff a mixture, whereas reduction in powder content by 50% would produce a satisfactory reline material.

The manufacturers of both materials recommend alterations in the powder to liquid ratios for use in different clinical situations. In the case of Ivoseal this alteration is pro-

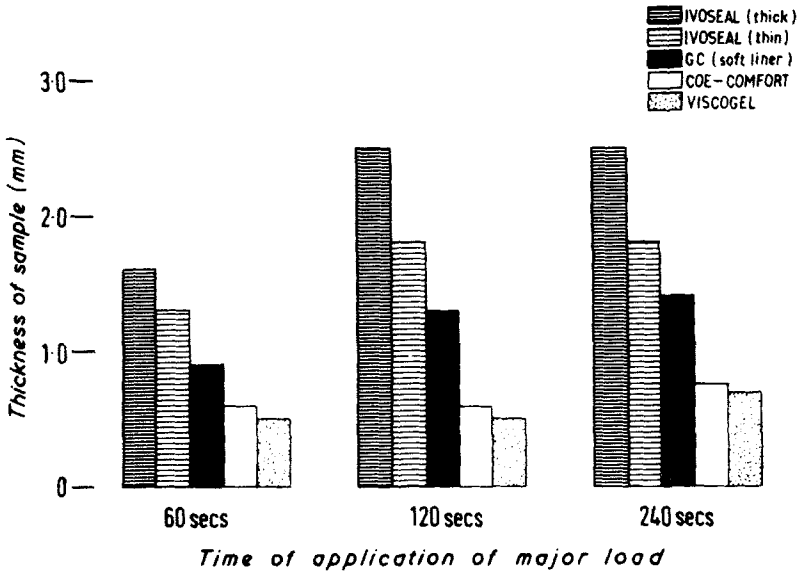

Fig. 7. Bar diagram illustrating the relationship between the time of application of the major load and the thickness of sample produced.

duced by reducing the powder content by 10% (described as a 'thin' mixture). The instructions for Viscogel recommend a non-specific increase in powder content for use in situations in which a stiffer mixture is required. Mixtures of the materials with alternative powder to liquid ratios were tested with the parallel-plate plastimeter, and the results are presented in Fig. 8. It can be seen that by altering the powder to liquid ratios of both the materials, the resulting thickness of the sample was altered. Thus, by increasing the powder content of Viscogel by 50% and by delaying application of the major load, a conditioning layer was produced which approached the thickness achieved with the standard mix of Ivoseal. Similarly, by decreasing the powder content

Table 2. Summary of clinical assessment of flow of Viscogel and Ivoseal on the basis of criteria described in the text (+ = satisfactory; − = unsatisfactory)

	Clinician								
Mix*	i	ii	iii	iv	v	vi	vii	viii	Remarks
Viscogel									
1	+	+	−	−	+	+	+	+	Sticky, air bubbles
2	+	+	+	+	+	+	+	+	
3	+	+	−	−	+	−	−	−	Not completely solidified
4	−	−	−	−	−	−	−	−	Folds, air bubbles, too hard
5	−	−	−	−	−	−	−	−	Not solidified
Ivoseal									
1	+	+	+	+	+	+	+	+	
2	−	−	+	−	−	−	−	−	Insufficient flow to be able to seat denture correctly, powdery surface
3	+	+	+	+	+	+	+	+	Slightly irritating for patient
4	−	−	−	−	−	−	−	−	Poor flow, folds present
5	−	−	+	+	−	−	−	−	Air bubbles, irritating for patient

* Mix 1 = manufacturer's recommendation; Mix 2 = an increase of powder by 50%; Mix 3 = a reduction of powder by 50%; Mix 4 = an increase of powder by 100%; and Mix 5 = a reduction of powder by 75%.

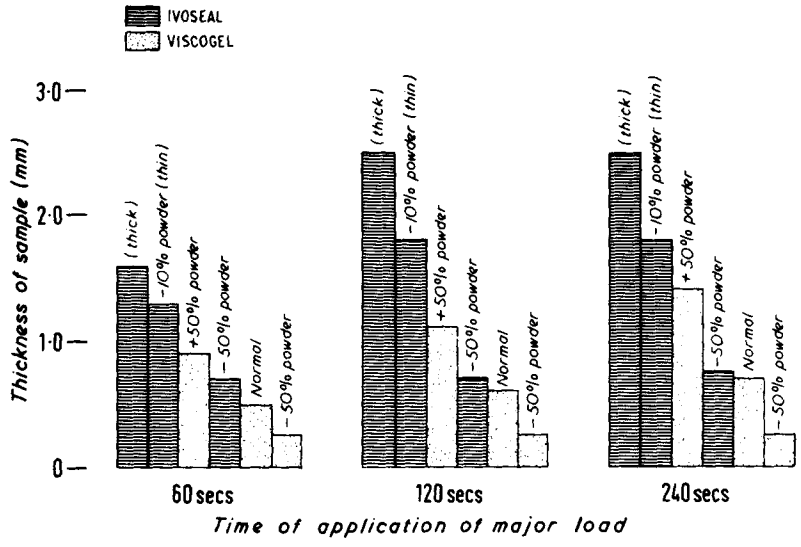

Fig. 8. Bar diagram summarizing the relationship between the time of application of the major load and the thickness of sample produced for the range of acceptable mixes of Ivoseal and Viscogel.

of Ivoseal by 50%, a lining was produced similar in thickness to the standard mix of Viscogel.

Clinical assessment of softness

It is generally accepted that, to act satisfactorily as a tissue conditioner, the material must effectively distribute the applied functional load, thus permitting the mucosal tissues to return to normal. The tissue conditioner is intended to minimize concentrations of mechanical stress in the denture-bearing mucosa, and therefore the degree of softness of the material is an important consideration.

The percentage figures shown in Tables 3 and 4 represent the views of the 40 clinicians on the softness of different mixtures of Viscogel and Ivoseal. For each variable the percentage figure is the measure of satisfaction; the trend of the other answers is reported as 'soft' or 'hard'. The views provide an indication of the level of satisfaction felt by these clinicians when asked whether they considered the material to be suitable for

Table 3. Clinical opinion on softness of Viscogel

	Mix 1, recommended mix		Mix 2, −50% powder		Mix 3, +50% powder	
Age	1 mm	2 mm	1 mm	2 mm	1 mm	2 mm
1 day	Satis. 50% Hard Soft	Satis. 43% Soft	Satis. 7% Soft	Satis. 7% Soft	Satis. 33% Hard	Satis. 55% Hard
3 days	Satis. 48% Hard Soft	Satis. 45% Soft	Satis. 15% Soft	Satis. 17% Soft	Satis. 36% Hard	Satis. 50% Hard
7 days	Satis. 55% Hard	Satis. 52% Soft	Satis. 17% Soft	Satis. 27% Soft	Satis. 29% Hard	Satis. 43% Hard
28 days	Satis. 50% Hard	Satis. 69% Hard Soft	Satis. 37% Soft	Satis. 30% Soft	Satis. 7% Hard	Satis. 12% Hard

Table 4. Clinical opinion on softness of Ivoseal

	Mix 1, recommended mix		Mix 2, −50% powder	
Age	1 mm	2 mm	1 mm	2 mm
1 day	Satis. 20% Hard	Satis. 53% Hard	Satis. 37% Hard	Satis. 66% Soft
3 days	Satis. 10% Hard	Satis. 43% Hard	Satis. 39% Hard	Satis. 68% Hard Soft
7 days	Satis. 3% Hard	Satis. 28% Hard	Satis. 21% Hard	Satis. 71% Hard
28 days	Satis. 0% Hard	Satis. 3% Hard	Satis. 3% Hard	Satis. 24% Hard

conditioning traumatized mucosa. Attention is drawn only to those trends that appear to be of clinical relevance.

For Viscogel (Table 3) opinions were divided when considering Mixture 1 (the manufacturer's recommendation). In a 1-mm thickness the material was thought to be too rigid, whereas in a 2-mm thickness the reverse applied. Mixture 2 (a 50% reduction of powder) was found to be totally unacceptable, with most samples rejected as being too soft. Mixture 3 (50% more powder) brought a slightly higher level of satisfaction, but only to the 2-mm-thick specimens, Again, the level of satisfaction was reduced markedly with increased age of specimen.

For Ivoseal (Table 4) in the case of Mixture 1 (the manufacturer's recommendation) there was generally a low level of satisfaction, with the opinion that the material was too hard in both 1-mm and 2-mm thicknesses. Mixture 2 (a reduction in powder content of 50%) was felt to be more suitable but only when presented as a 2-mm-thick sample, the material being too hard when only 1 mm thick. The 2-mm-thick specimen appeared to be satisfactory for at least up to 7 days.

Conclusions

The results from this study indicate that a 2-mm thickness of temporary soft lining material is more suitable than a 1-mm thickness. To produce the optimum thickness, the patient's closing force must be carefully controlled when the mixed material is placed in the mouth. Needless to say, it is important to ensure that the existing freeway space of a set of dentures will allow a sufficient thickness of the soft material to be inserted.

Thickness is influenced by the powder to liquid ratio. However, the scope for altering this ratio is limited, as the clinical tests on flow and resilience indicate.

This study confirms the views of other authors (2, 3) that temporary soft lining materials, if used to condition traumatized mucosa, are generally unlikely to be satisfactory after 7 days, at which time they should be replaced.

It is planned to apply more sophisticated laboratory tests to these mixtures to establish realistic specification criteria. The results of these tests will be presented in a subsequent paper.

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