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A TECHNIQUE FOR THE PREPARATION OF COMPARABLE AMALGAM SPECIMENS STANDARDISED BY MERCURY CONTENT

by

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The standardisation of amalgam specimens has been the aim of a number of research workers. Various techniques have been described, notably by *Ware & Docking* (1954), *Swartz & Phillips* (1956), *Ryge et al.* (1957), and *Hatt* (1959). *Ryge et al.* (1952) demonstrated discrepancies between different operators. In general, however, detailed analyses of the accuracy of the methods employed do not seem to have been reported.

The American Dental Association Specification No. 1 for Dental Amalgam Alloys recommends that the directions for use as recommended by the manufacturer which are in accordance with established dental practice should be followed. It is questionable, however, if the procedure adopted in day to day practice meets the requirements of scientific accuracy in relation to the testing and comparing of different types and batches of alloys.

It is well-established that the quantity of residual mercury effects the physical properties of a single type of amalgam. Accordingly, the standardisation of mercury content of the specimens can serve as a basis for their comparison. Not only uniformity within the test series but also within a single specimen would be a basic requirement. The packing and condensing of amalgam manually by various operators cannot be expected to result in comparable specimens.

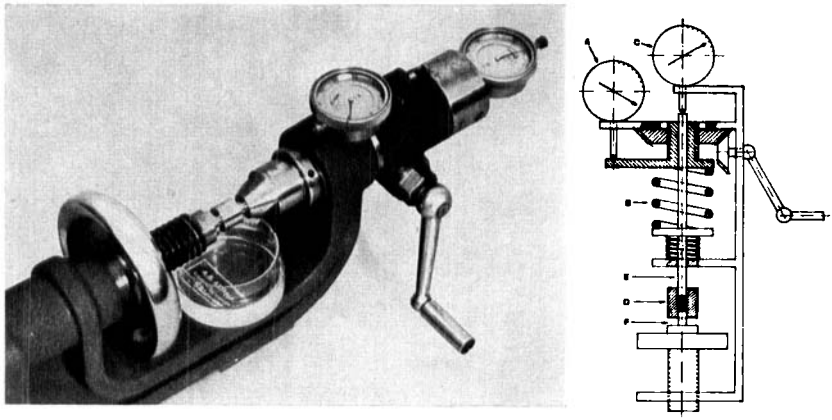

Figure 1. Left Alpha "Sklerometer", 2 H 547, adjusted for condensation of amalgam specimens. Right a schematic drawing of the principle; A: lower indicator dial, B: coil-spring, C: upper indicator dial, D: mould with amalgam, E: indenter attached to the apparatus, F: plate with indenter.

The aim of this paper is to describe a technique incorporating mechanical amalgam condensation which results in specimens containing commensurable quantities of mercury distributed throughout as uniformly as possible.

TECHNIQUE AND APPARATUS

In this study two alloys are used. The first is a pre-amalgamated fine grain type (I) with an alloy/mercury ratio of 5:5 while the other is a coarse-filed type (II) with a ratio of 5:7. The alloy and mercury are weighed approximately on a standard balance for clinical use and triturated in a mechanical amalgamator, type Crescent's Wig L Bug. The condensation is performed in the apparatus described below. All steps are carried out under optimal time conditions.

An apparatus, type Alpha 2 H 547, Sundbyberg, Sweden, designed for compressive and bending tests, was used for the condensation, as seen in Figure 1. The loading, which is recorded on the lower indicator dial in hundredths of a millimeter, is achieved by setting a coil-spring with the handle. This value is transformed to kilograms by way of a diagram. The compression is read from the upper dial which registers the movement of

the indenter. The value of the lower dial, however, is reduced with increased reading of the upper. In order to use a constant load during the condensation time, the operator must thus continuously compensate for the movement of the indenter.

The apparatus is placed in a horizontal position as seen in Figure 1. This arrangement is preferred because of the fact that vertical condensation results in specimens with a larger amount of mercury in their lower portions.

In order to avoid any uncontrolled effect caused by starting condensation with the spring unloaded, this is constantly stressed to a value of one millimeter on the lower dial with the upper one registering zero.

The equipment otherwise consists of steel moulds, the machined internal bores of which vary in diameter. To each type of mould belongs one indenter attached to the apparatus with

Table I.

Series	No. of specimens	Alloy	Condensation pressure in kg/cm²	Condensation time in min.	Specimen diameter-length in mm	Mercury amount as a %		
						Mean	S. D.	Range
1	5	I	140	5	10 — 6	41.5	0.14	0.4
2	5	I	140	3	10 — 6	42.2	0.20	0.4
3	5	I	140	1	10 — 6	43.3	0.13	0.3
4	5	I	70	3	10 — 6	45.1	0.24	0.6
5	5	I	70	1	10 — 6	45.6	0.22	0.5
6	5	II	140	3	10 — 6	51.9	0.16	0.4
7	5	II	140	1	10 — 6	52.4	0.22	0.5
8	5	II	70	3	10 — 6	55.2	0.37	0.9
9	5	II	70	1	10 — 6	55.6	0.35	0.8
10	5	I	140	1	5 — 10	44.6	0.37	1.0
11 central	5 parts	I	140	1	5 — 10	45.1	0.58	1.4
12 periph.	10 parts	I	140	1	5 — 10	44.3	0.33	0.9

In series 1 alloy and mercury were weighed with an accuracy of ± 1 mg; in series 2—12 these components were only approximately weighed.

its free end planed, a plate with another indenter, and a split ring. The ring is placed between the plate and the mould, and its thickness is matched to the amalgam portion used so that this can be placed in the middle of the mould before condensation starts. The indenters fit very well into the moulds, varying in diameters by only one to two hundredths of a millimeter.

TEST SERIES

The series in which the technique was tested are outlined in Table I. As can be seen, the influence of condensation time and pressure was studied in addition to the effect of precise as distinct to only approximate weighing of alloy and mercury. Furthermore, the distribution of mercury within the specimen itself was investigated. Ten specimens were prepared for series 10, 11, and 12. Five were randomly chosen for series 10, the remaining five making up series 11 and 12; series 11 consisting of central portions and series 12 of peripheral portions.

MERCURY ANALYSES

The mercury analyses were performed in accordance with a method of complexometric titration of *Bladh & Månsson*.[1]

The error of the method (S.D.), based on the determination of two series comprising 6 and 7 single analyses respectively, was found to be 0.3—0.2 % absolute amount mercury.

Each specimen was pulverised, passed through a sieve of sixty meshes per cm and a mesh width of 0.1 mm, and analysed as a double test. The tolerated range in absolute amount residual mercury was 0.3 %.

RESULTS AND DISCUSSION

From the results, seen in Table I, it can be concluded that the technique permits a high degree of standardisation of mercury

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[1] This method has been worked out at the Department of Analytical Chemistry(Head: Dr. *K. J. Karrman*), University of Lund, and will be published in the near future in a journal of analytical chemistry.

content. Within the limits used, 70—140 kg/cm² and 1—3 min., condensation pressure, but not time, seems to influence the accuracy to some extent. Exact as opposed to only approximate weighing of the alloy and mercury caused practically no differences. Section analyses showed that the central portion of the horizontally condensed specimen contains a somewhat larger amount of mercury than the peripheral parts. Furthermore, it seems likely that the configuration of the specimen influences the accuracy of the method.

The first question to be raised will probably consider the value of the technique described in relation to hand packing methods. This is ignored for two reasons: Firstly, no definite recommendations are made in the literature concerning the tolerated mercury range for different subjects of investigation. Secondly, because of difficulties in obtaining representative values for hand packed series, a very large number of tests with different techniques performed by operators specially trained for the purpose would be needed.

It seems reasonable that a range greater than 1 % of residual mercury content would not be accepted in laboratory investigations. (In a series of five specimens of normal variation this gives a standard deviation of 0.4 %). The comparatively high S.D. in series 11 results from the fact that one value (44.2 %) deviated markedly from the mean (45.1 %). It was the only one so observed throughout the investigation, however. Some uncompensated manual fault was probably the cause.

Experiments on hand packing performed for this purpose have shown that it is possible to work within the range of 1 % under favourable conditions with a trained staff. Nevertheless, with the help of a mechanical amalgamator, a machine condensation procedure, and time control, it is possible to obtain even higher standardisation. The importance of this can be exemplified with results from measurement of dimensional changes during setting. In a series of five specimens the twenty-four hour values gave a standard deviation of 0.8 microns.

The somewhat larger quantity of mercury present in the central portion of the specimens is a definite disadvantage. The effect of this in relation to different tests is impossible for the author to evaluate at present. The technique has been judged as

acceptable, however, for indentation hardness tests on specimens (*Granath*, 1961) as well as for experiments on dimensional changes and adaptation (unpublished paper). For static and dynamic tests involving the deformation of the whole specimen a new mould construction, which will permit a continuous outflow of mercury from the total mantle surface, is under development.

SUMMARY

A condensation technique for standardised amalgam specimens is presented, in which the quantity of residual mercury in the specimen serves as a basis for their comparison. After a short discussion regarding the requirements of uniformity both within the test series and within the single specimen, the condensation apparatus is described. This permits the static condensation of the specimen in a horizontal position (Figure 1). Compensation for the compression of the specimen is continuously made. Horizontal rather than vertical condensation results in more uniform distribution of mercury. Table 1 indicates the high degree of standardisation obtainable.

RÉSUMÉ

TECHNIQUE POUR LA PRÉPARATION DE SPÉCIMENS COMPARABLES D'AMALGAME STANDARDISÉS PAR LA TENEUR EN MERCURE

L'auteur présente une technique de condensation destinée à obtenir des spécimens standardisés d'amalgame, la comparaison entre les spécimens étant basée sur la quantité de mercure résiduel qu'ils contiennent. Après une brève discussion sur les exigences d'uniformité en ce qui concerne les séries d'épreuves et en ce qui concerne les spécimens particuliers, vient une description du dispositif de condensation. Celui-ci permet la condensation statique des spécimens en position horizontale (Figure 1). La compensation à la compression du spécimen est faite d'une manière continue. L'emploi d'une condensation horizontale de préférence à une condensation verticale donne une répartition plus uniforme du mercure. Le tableau I indique le degré élevé de standardisation susceptible d'être obtenu.

ZUSAMMENFASSUNG

EINE TECHNIK ZUR HERSTELLUNG VON VERGLEICHBAREN PROBEKÖRPERN MIT STANDARDISIERTEM QUECKSILBERGEHALT

Eine Kondensationsarbeitsweise für die Standardisierung von Amalgamprobekörpern wird beschrieben. Als Kontrolle dient die verbleibende Quecksilbermenge im Probekörper. Nach einer kurzen Diskussion über die Forderungen der Einheitlichkeit, sowohl innerhalb der Testserien als auch innerhalb des einzelnen Probekörpers wird der Kondensationsapparat beschrieben. Dieser lässt eine statische Kondensation mit dem Probekörper in der Horizontallage zu, Abb. 1. Die Kompression des Probekörpers wird laufend ausgeglichen. Die horizontale Kondensation gestattet eine mehr einheitliche Verteilung als eine vertikale Kondensation. Ein hoher Grad der Standardisierung kann erreicht werden, Tabelle I.

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