Bull. Tokyo Med. Dent. Univ., 18: 161–167, 1971.

POROSITY OF SPHERICAL AND CONVENTIONAL AMALGAMS

BY

Toshio TAKATSU, Koji DAITO and Takao FUSAYAMA*1

ABSTRACT

In order to compare the porosities of a spherical alloy amalgam and a conventional alloy amalgam, the ground sections of amalgam mixes and fillings condensed by varying techniques and pressures were examined.

The conventional amalgam generally had little porosities in its mixes but had gross porosities along the junctions of increments in its fillings. Such porosities could be eliminated by efficient condensation.

The spherical amalgam had many minute porosities in its mixes. The porosities along the junctions of increments were much less and smaller in its fillings but minute porosities distributed in the whole masses could not be eliminated even by the most efficient condensation.

INTRODUCTION

Residual mercury content[1] and porosity[2] are two main factors influencing the strength of amalgam. In the present study, effect of the types of material and condensing technique on the porosity was investigated by using a spherical and a conventional amalgam alloy.

METHOD

Materials. A spherical alloy*2 and a conventional alloy*3 from the same manufacturer were compared. The former in 1.0 g was mixed with 0.8 g of mercury and triturated for 10 seconds by a mechanical amalgamator*4. The latter in 1.0 g was mixed with 1.4 g of mercury and triturated for 30 seconds by the amalgamator and excess 0.2 g of mercury was removed using a Nylon cloth.

*1 高津寿夫, 大藤幸司, 総山孝雄: Department of Operative Dentistry (Chief: Prof. T. FUSAYAMA), School of Dentistry, Tokyo Medical and Dental University (Tokyo Ika Shika Daigaku).

Received for publication, March 12, 1971.

*2 Spherical Alloy Non-Zinc (B.N. 177).

*3 Micro Non-Zinc Alloy (B.N. 43).

*4 Shofu Spherical Amalgam Mixer.

Preparation of specimens. An experimental cavity of acrylic resin, which was originally designed for the previous experiment of adaptation test[3], was used (Fig. 1).

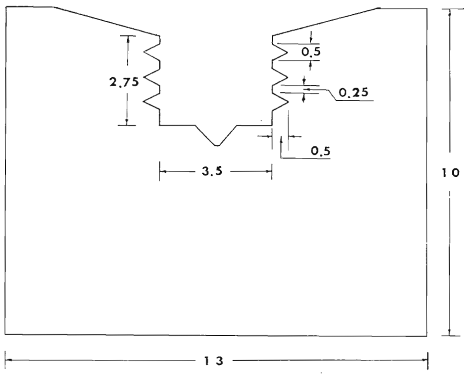

Fig. 1. The design of the vertical section of the plastic experimental cavity for observing amalgam porosity, (with figures in mm) which was originally designed for adaptation test.

Three types of condenser (a hand condenser, an electro-mechanically driven horizontal vibrator*5 and a mechanically driven vertical vibrator*6 were used with round ends of 2.5 mm diameter. A cavity was filled with three increments, each of which was condensed 10 times by the hand condenser or 5 times by one of the vibrators. The condensing pressure was regulated to 10 or 30 kg/cm^2, the range clinically common and adequate for the above-described techniques, by using a pressure regulator of hung load type[4]. After overpacking, a hand burnisher was used to remove excess and burnish the surface. Five specimens were prepared for each group.

After 24 hours, longitudinal section surfaces approximately through the axes were produced by reducing from one side with a water-proof emery paper under running water. The specimens were imbedded in a polyester resin with the section surfaces exposed. After the polyester resin had set, the amalgam surfaces were polished by a routine technique and finally buffed with a suspension of 0.5-μ alumina powder. The section surfaces of amalgam mix balls left without filling were also prepared by the same technique.

Observation of porosity. Specimens were photographed by a microscope of 12.5 magnification to cover the whole amalgam surface in a view. The porosity was observed with the naked eye on the photographs. The

*5 Auto-Plugger, Shofu Dental Mfg. Co., Kyoto.

*6 Amalpac, Morita Dental Mfg. Co., Tokyo, Japan.

point counter technique[5] was also tried to quantify the porosity but was found ineffective because the size of porosity was so varied including microfine pores. The characteristics of groups could, however, be clearly compared by observing the magnified photographs.

Results

Porosity in the amalgam mixes. The conventional amalgam mix showed fewer and smaller porosities, while the spherical amalgam mix showed many porosities of various sizes (Fig. 2).

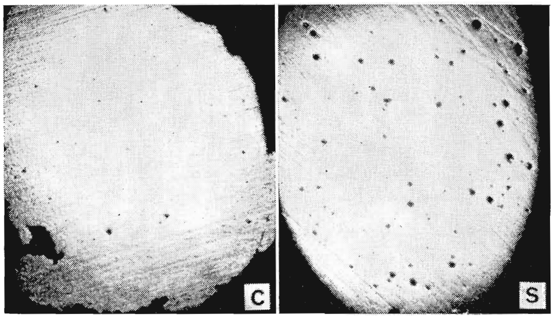

Fig. 2. Sections of amalgam mix balls made from the conventional (C) or the spherical (S) alloy and left without filling.

Porosity in the amalgam fillings. The conventional amalgam fillings generally showed gross porosities in lines between increments with little porosity inside increments (Fig. 3). Porosity was least with the vertical vibrator, more with the horizontal vibrator, and most with the hand condenser, with remarkable differences. Porosity generally decreased with increased condensing pressure. Such a change in porosity due to pressure was slight with the vertical vibrator and greatest with the hand condenser.

The spherical alloy amalgam did not tend to show gross porosities gathering particularly between increments but many minute porosities were observed rather homogeneously scattered in the whole mass (Fig. 4). Porosities scarcely decreased with increased condensing pressure. Difference in porosities due to different types of condenser was also slight. When carefully observed by a higher magnification, however, the specimens made with the hand condenser sometimes showed extremely minute porosities between increments but not the specimens made with the vibrators (Fig. 5).

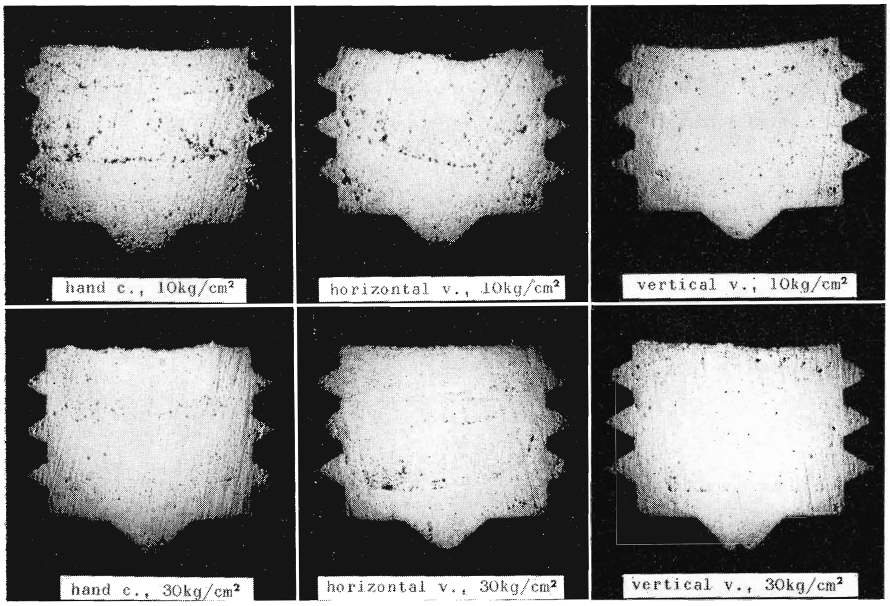

Fig. 3. Vertical sections of the conventional amalgam fillings condensed with three different condensers under two different pressures.

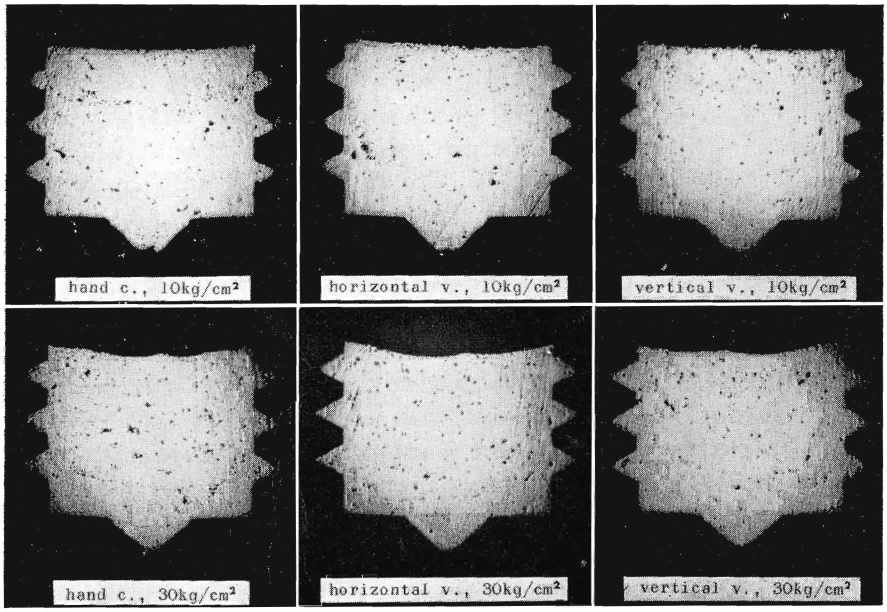

Fig. 4. Vertical sections of the spherical amalgam fillings condensed with three different condensers under different pressures.

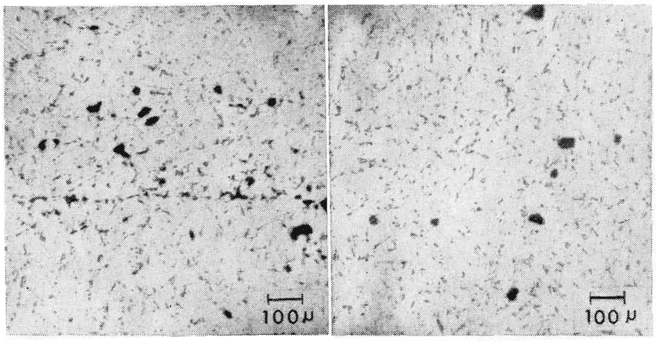

Fig. 5. Porosities between increments of the spherical amalgam fillings condensed with hand condenser (left) and the vertical vibrator (right), observed by a higher magnification.

Discussion

The conventional amalgam alloy having a complicated shape and greater surface area required more mercury to mix and resulted in greater amount of matrix[6]. Therefore, the spaces between particles were better filled with matrix, so that less porosities would be left in the mix. The irregular shape of particles, however, disturbed sliding between them resulting in less plasticity[7]. The increments were thus less adaptable to each other and gross porosities were apt to appear in lines between them. Such a lack in adaptability could be overcome by increasing the condensing pressure or by using more efficient mechanical condensers, in accordance with previous reports[8,9].

Spherical amalgam alloy particles had smaller surface area and less mercury was used with them. As pointed out by Wing and Ryge[10], spherical alloy particles were attacked only very superficially by mercury leaving the greatest parts unreacted. The amount of matrix was thus too small to completely fill the spaces between particles and minute porosities were therefore left in the amalgam mix. Such porosities were difficult to be eliminated even by efficient condensing techniques because unreacted alloy particle cores were closely in contact with each other, keeping unfilled spaces between them. The spherical shape of the particles, however, facilitated plastic deformation of the mix and porosities were less apt to be produced between increments.

Thus, porosity was present more in the conventional amalgam than in the spherical amalgam when poorly condensed but less in the former when efficiently condensed.

Conclusion

Porosities of a spherical alloy amalgam and a conventional lathe-cut alloy amalgam were compared by observing the ground sections of their mixes and fillings condensed with a hand condenser, an electromagnetic horizontal vibrator or a mechanical vertical vibrator under 10 or 30 kg/cm^2 pressure. Findings were as follows:

1. The conventional amalgam generally showed little porosities in its mixes but gross porosities appeared along the junctions of increments when filled. Such porosities could, however, be eliminated by efficient condensation.
2. The spherical amalgam showed many minute porosities in its mixes. When filled, gross porosities did not appear along the junctions of increments but minute porosities remained in the increments and could not be completely eliminated even by the most efficient condensation.
3. Porosity of the conventional amalgam was least with the vertical vibrator, more with the horizontal vibrator, and most with the hand condenser. It decreased with the higher condensing pressure. Such a change in porosity due to condensing technique was very slight for the spherical amalgam.

Acknowledgement

The authors acknowledge with thanks the constructive advices and assistance of Doctors Sadao Wakumoto and Takeshi Kitagawara.

References

1) Swartz, M. L., and Phillips, R. W.: Residual mercury content of amalgam restoration and its influence on compressive strength. J. Dent. Res., 35: 458–466, 1956.
2) Jorgensen, K. D., Esbensen, A. L., and Borring, M. G.: The effect of porosity and mercury content upon the strength of silver amalgam. Acta Odontol. Scand., 24: 535–553, 1966.
3) Takatsu, T., Nakazawa, Y., Shioji, S., Kato, S., Watanabe, M., Wakumoto, S., and Yamaguchi, S.: Adaptability of spherical and lathe cut alloy amalgams. (in Japanese, English abstract). J. Jap. Res. Soc. Dent. Mater. Appliances, 19: 18–21, 1969.
4) Fusayama, T., Shimizu, M., Hosoda, H., and Horibe, T.: Early and transversal measurement of amalgam expansion. J. Dent. Res., 43: 194–206, 1964.
5) Jorgensen, K. D., and Kanai, S.: Struktrundersogelser af amalgam. I. Korrelation mellem struktur og fysiske egenskaber. Tandlaegebladet, 68: 659–668, 1964.
6) Nagai, K., Ohashi, M., and Miyazu, H.: Studies on spherical amalgam alloy in the light of dental technology. J. Nihon Univ. Sch. Dent., 8: 149–186, 1967.
7) Mahler, D. B.: Plasticity of amalgam mixes. J. Dent. Res., 46: 708–713, 1967.
8) Fusayama, T., Katayori, T., and Shimizu, M.: Compressive strength of amalgam

as influenced by the use of various amalgamators and condensers. (in Japanese, English abstract). Jap. J. Conserv. Dent., 3: 190–197, 1960.

9) Wing, G.: The condensation of dental amalgam. Dent. Practioner, 16: 52–59, 1965. 1965.

10) Wing, G., and Ryge, G.: Setting reaction of spherical-particle amalgams. J. Dent. Res., 44: 1325–1333, 1965.