MEMOIRS OF THE FACULTY OF ENGINEERING
FUKUI UNIVERSITY
VOL.26 No.2 1978

A Study on the Adhesion of the Composite Denture

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(Received June 15, 1978)

In this paper we describe an experimental study, in the preceding article, authors reported about the abrasion for composite teeth, in this article are a composite denture which was newly made combining merits of the porcelain and the plastic teeth, a trial production of composite materials of the porcelain and the plastic teeth, and an experimental study of adhesion property of the composite tooth.

The following summary can be made from the results of the present experiments. Adhesion of composite denture with filler of porcelain element in principal can be fully expected. In comparison with adhesion strength of P.M.M.A. to P.M.M.A., tensile joint efficiency adhered by P.M.M.A. of heat-cured type was 84-100%, while that of P.M.M.A. of low temperature cured type was 97-98%. Bending joint efficiency using the former adhesive was 87-94%, while that of the latter adhesive was 83-85%.

1. INTRODUCTION

Porcelain tooth and plastic tooth are typical example of artificial tooth. The former is superior in terms of abrasion resistance and discoloration, while it is weak against impact force because of hardness and brittleness.[1] On the other hand, as the plastic tooth is relatively inferior in hardness and abrasion resistance, there is a possibility that its surface may wear out and deteriorate in esthetic point of view through daily brushing. However, it has big resistance against impact force and is hardly damaged. It should also be noted that there occur no cracks in resin base around the artificial tooth, since thermal expansion modulus of the plastic tooth is same as that of the resin base, and that no special supporting device is required as the plastic

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tooth can be adhered directly to the resin base.[2] Reported in this article are a composite denture which was newly made combining merits of the porcelain and the plastic teeth, a trial production of composite materials of the porcelain and the plastic teeth,[3] and an experimental study of adhesion property of the composite tooth.

2. EXPERIMENTAL MATERIALS AND EXPERIMENTAL METHOD

Composite materials were of P.M.M.A./feldspar, P.M.M.A./china-clay, P.M.M.A./silica and P.M.M.A./porcelain. Fineness of inorganic material powder was less than 60μ, which powder was mixed with P.M.M.A. by 10-30 wt.% for molding. Molding condition of composite materials and P.M.M.A. (denture acrylic, SHOFU "Bio" resin) was that after heating and pressurizing to 100°c and 100kg/cm^2 for 45 minutes, the mold was cooled down naturally. After molding, the materials were processed into test pieces of long rectangular shape of 50 x 10 x 2mm, which were then butt-jointed by filling into 1mm root gap a P.M.M.A. of heat-cured type or a P.M.M.A. of low temperature cured type. Adhesion condition of heat-cured type was 100°c for 45 minutes, while that of low temperature cured type was 20°c for 60 minutes. For adhesion test, Instron type tester, Autograph IS-2000, was used, with which tensile strength at loading speed of 10mm/min was measured. Also the fracture after adhesion test was observed with scanning type electron microscope to find out adhesion mechanism from condition of failure. Bending test was carried out to find out bending strength by applying load to cause 3-point bending of 50mm span length to adhesion part of the said test

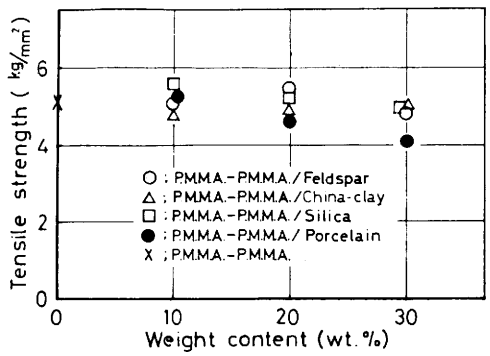


Fig.1 Relation between tensile strength and weight content. (hot polymerization bonding: root gap; 1mm)

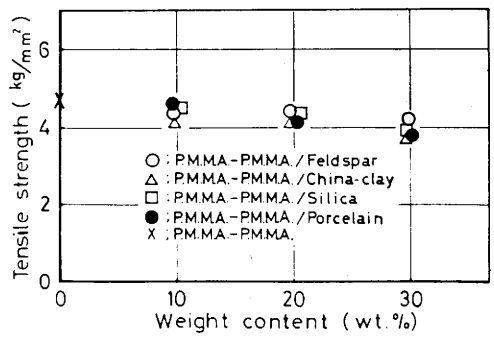


Fig.2 Relation between tensile strength and weight content. (cold polymerization bonding: root gap; 1mm)

pieces of long rectangular shape. In an assumption of adhesion of composite denture to resin bed, adhesion test was carried out with P.M.M.A. and various composite dental materials.

3. EXPERIMENTAL RESULTS AND CONSIDERATION

Fig.1 shows the results of tension test, in which adhesion strength of various composite dental materials butt-jointed by heat-cured type P.M.M.A. as adhesive was looked for. Compared with 5.0kg/mm^2 adhesion strength of P.M.M.A. to P.M.M.A., various composite dental materials did not show any deterioration in adhesion strength and maintained 5.0kg/mm^2 strength, even though inorganic material filling in composite dental materials was increased from 10% to 30%, with the only exception of porcelain filling composite dental materials which showed adhesion strength of 4.6 and 4.2kg/mm^2 with 20% and 30% filling respectively. Fig.2 shows the results of the similar experiment, but using P.M.M.A. of low temperature cured type as adhesive. Compared with 4.7kg/mm^2 strength of P.M.M.A. to P.M.M.A., adhesion strength of composite dental materials of inorganic filling was almost same and showed 4.0-4.5kg/mm^2. In this case, however, strength showed tendency to drop slightly as filling increased to 10-30%. Tensile joint efficiency of composite dental materials was 84-100% and 79-98% with P.M.M.A. of heat-cured type and of low temperature cured type, respectively. Fig.3 shows the results of bending test conducted to adhesion part of composite dental materials filled with various inorganic materials, which adhesion was made by P.M.M.A. of heat-cured type. Compared with 7.9kg/mm^2 strength

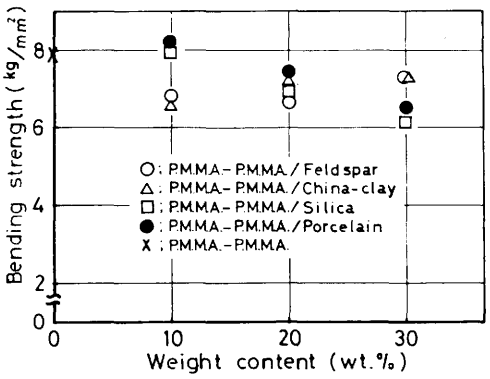


Fig.3 Relation between bending strength and weight content. (hot polymerization bonding: root gap; 1mm)

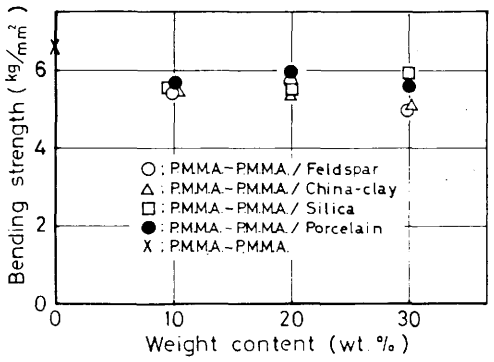
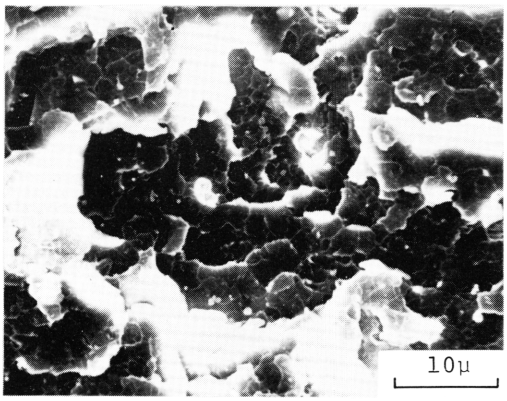
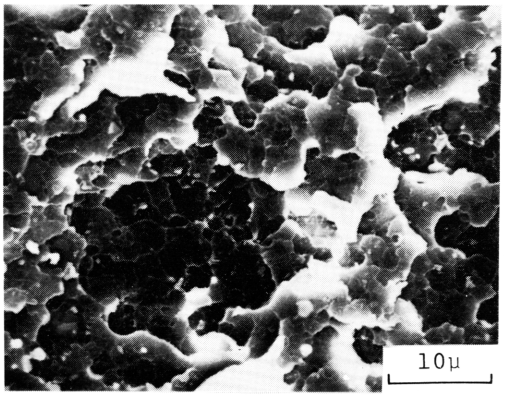


Fig.4 Relation between bending strength and weight content. (cold polymerization bonding: root gap; 1mm)

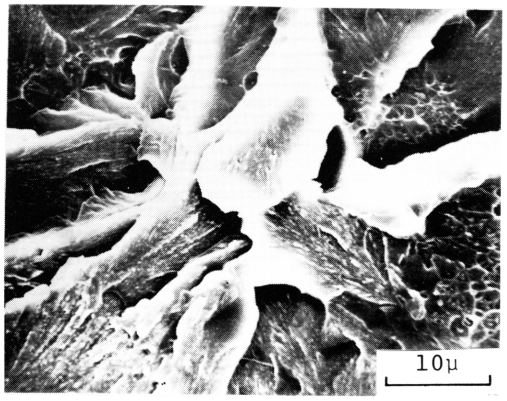
of P.M.M.A. adhered to P.M.M.A., composite materials showed bending strength of 6.9-7.4kg/mm^2. These materials further showed tendency to drop in their bending strength as filler increased, and their joint efficiency was 87-94%. Fig.4 shows bending strength at adhesion part of composite dental materials adhered by P.M.M.A. of low temperature cured type. Bending strength of various composite teeth was 5.4-5.5kg/mm^2, whose bending joint efficiency was 83-85% compared with 6.5kg/mm^2 bending strength of P.M.M.A. adhered to P.M.M.A., and showed very little change in strength by increasing filler. Photo.1 show tensile fractures of the adhesion part of composite materials observed by scanning type electron microscope, which adhesion was carried out by using P.M.M.A. of heat-cured type as adhesive.



(a) Fracture surface at the interface between composite material and adhesive layer. [hot polymerization bonding between P.M.M.A. and feldspar (30 wt.%)/P.M.M.A. composite material]

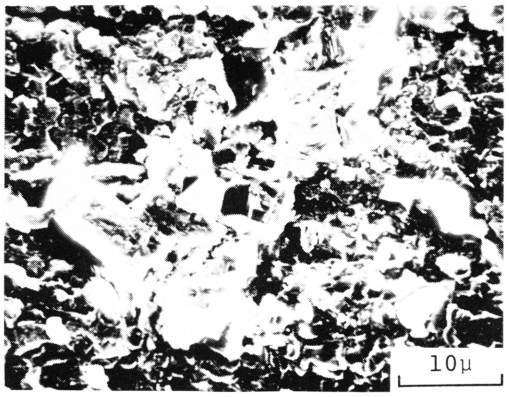


(b) Fracture surface at the interface between P.M.M.A. and adhesive layer. [hot polymerization bonding between P.M.M.A. and porcelain(10 wt.%) /P.M.M.A. composite material]

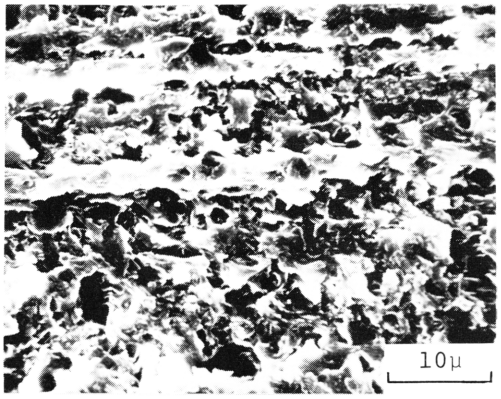


(c) Fracture surface at adhesive layer. [hot polymerization bonding between P.M.M.A. and porcelain(10 wt.%)/P.M.M.A. composite material]

Photo.1 The appearances of tensile fracture surfaces of hot polymerization bonded specimens.



(a) Fracture surface at the interface between composite material and adhesive layer. [cold polymerization bonding between P.M.M.A. and feldspar (20 wt.%)/P.M.M.A. composite material]



(b) Fracture surface at the interface between P.M.M.A. and adhesive layer. [cold polymerization bonding between P.M.M.A. and porcelain(30 wt.%)/P.M.M.A. composite material]

Photo.2 The appearances of tensile fracture surfaces of cold polymerization bonded specimens.

(a) shows the condition of interfacial failure which occurred on the side of composite material of P.M.M.A./feldspar (30%), and it is observed that there exist cohesion failure and interfacial peeling of adhesive. (b) shows the condition of interfacial failure which occurred on the side of base material (P.M.M.A.) of P.M.M.A./porcelain (10%), and it is observed as well that there exist cohesion failure and interfacial peeling of adhesive. (c) is cohesion failure of adhesive of composite material as in the case of (b), and ductile failure of P.M.-M.A. is observed. Failures of materials whose tensile joint efficiency was 100% are shown in Photo.1, from which it is known that interfacial failure was either a failure in which the adhesive and the material to be adhered were intermingled each other or a cohesion failure within the adhesive. It can be said that as a whole there were a good many of interfacial failure on the side of composite material. Photo.2 are the pictures of tensile fractures taken by a scanning type electron microscope, which fractures occurred in adhesion part of composite materials adhered by P.M.M.A. of low temperature cured type. (a) shows interfacial fracture which took place on the side of composite material of P.M.M.A./feldspar (20%), while (b) shows that of composite material of P.M.M.A./porcelain (30%). It is known from these pictures that both of them are

interfacial peeling, and marks of emery paper are observed in adhesion surface of (b).

4. CONCLUSION

The following summary can be made from the results of the present experiments. As a result of this series of test and experiments, it was found that;

1) Adhesion of composite denture with filler of porcelain element in principal can be fully expected.

2) In comparison with adhesion strength of P.M.M.A. to P.M.M.A., tensile joint efficiency adhered by P.M.M.A. of heat-cured type was 84-100%, while that of P.M.M.A. of low temperature cured type was 97-98%.

3) Bending joint efficiency using the former adhesive was 87-94%, while that of the latter adhesive was 83-85%.

ACKNOWLEDGMENTS

The authors wish to express sincere thanks to Prof. Dr. Y.Kawamura, Prof. Dr. S.Kawai, Prof. Dr. R.Yamaga, Dr. Y.Okuno, Dr. Y.Moriwaki and Dr. H.Matsushiro of Osaka University Dental School for their encouragements and valuable discussions.

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