Porosity in resin composite core restorations: The effect of manipulative techniques

A. G. B. Mentink*/R. Meeuwissen*/P. P. M. Hoppenbrouwers*/A. F. Käyser*/J. Mulder**

Forty acrylic resin duplicates of an endodontically treated and extracted human molar were restored with two resin composite materials for core restorations. Two different manipulation techniques, bulk insertion and syringe application, were used. In a simulated clinical setup, the core buildups produced by the different manipulation techniques were investigated for voids. In 20 duplicates, a post was placed to simulate a metal post and resin composite core buildup. The syringe technique produced significantly fewer incorporated voids for both resin composite core materials than did the bulk insertion technique. It was not possible to demonstrate a relationship between the presence of voids and the presence of a metal post. (Quintessence Int *1995;26:811–815.*)

Introduction

For treatment of endodontically treated and broken-down teeth, many different prefabricated post systems are used in combination with a core of restorative material.[1-4]

The mechanical properties of a resin composite core restoration will be less than optimal unless correct placement is achieved. One of the problems in the fabrication of resin composite cores is the incorporation of voids. Incorporation of air rapidly reduces desirable features of the material.[5,6] Laboratory studies on the effect of manipulation techniques on porosity in resin composites have been performed, but molds or split molds have usually been used to simulate the restoration.[5-9]

The aim of this study was to investigate the effect of two different manipulation techniques on porosities in resin composite core buildups in a setup that simulates a clinical situation.

* Department of Oral Function and Prosthetic Dentistry, University of Nijmegen, School of Dentistry, Nijmegen, The Netherlands.

** Department of Applied Statistics, TRIKON: Institute for Clinical Research, University of Nijmegen, Nijmegen, The Netherlands.

Reprint requests: Dr A. G. B. Mentink, Department of Oral Function and Prosthetic Dentistry, University of Nijmegen, School of Dentistry, PO Box 9101, 6500 HB Nijmegen, The Netherlands.

Method and materials

A freshly extracted human mandibular first molar received a modified Class II preparation (Fig 1) and endodontic treatment (distal canal available for post placement). The preparation was then modified to simulate a more clinical situation for a post and core restoration. Forty acrylic resin duplicates of this molar were made and restored to include three variables:

1. Core material:
   a. Clearfil core (Cl) (Kuraray). Chemically cured resin composite, applied with the use of a metal matrix
   b. Photo core (Ph) (Kuraray). Light-cured resin composite, applied with the use of a transparent matrix and in four layers
2. Application technique:
   a. Bulk insertion technique (Bu) with a hand instrument (Lustra No. 3, Ash)
   b. Syringe technique (Sy) with a Hawe syringe (Hawe-Neos)
3. Post placement:
   a. Twenty specimens (RA) to receive a post (Radix No. 2, Maillefer)
   b. Twenty specimens (NO) to receive no post

The study had a balanced three-factor design, with two levels of variable core material (Cl or Ph), two

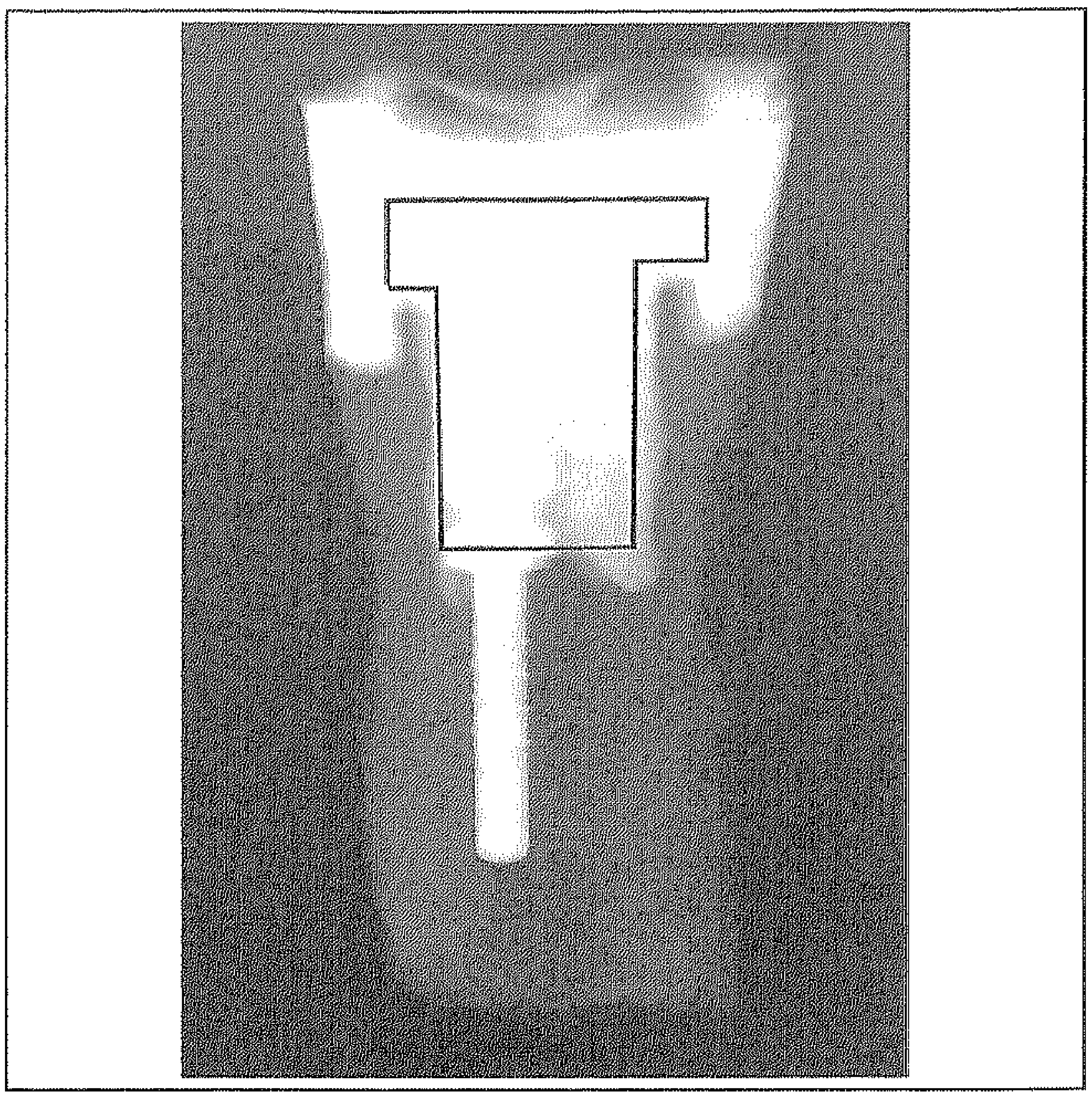

Fig 1 Enlarged radiograph of specimen with frame surface in which detection of voids was attempted.

Table 1 Void surfaces in the eight series (n = 40) of specimens

Series	n	n*	Mean void surface (mm^2)	SD	% of total surface
ClBuRa	5	5	585	240	6.0
ClSyRa	5	1	75	2	0.1
ClBuNO	5	5	709	305	7.4
ClSyNO	5	3	164	97	1.0
PhBuRA	5	4	195	164	1.6
PhSyRA	5	3	157	61	0.9
PhBuNO	5	5	366	124	3.8
PhSyNO	5	3	94	68	0.5
Total	*40*	*29*			

* The number of specimens in the series that contained a void surface.
Cl = Clearfil core; Ph = Photo core; Bu = bulk insertion; Sy = syringe insertion; RA = post; NO = no post.

levels of application technique (Bu or Sy), and two levels of post placement (RA or NO). The resulting eight experimental series were each assigned five specimens. A three-factor analysis of variances (ANOVA) was executed.

Standardized radiographs of all specimens were made in a buccolingual direction. For better interpretation of these radiographs, a ×12.5 magnification was produced with D-mac equipment (D-mac). The enlargements of the radiographs were traced for voids in a given frame within the resin composite core (see Fig 1). Three observers independently made tracings of the enlargements and scored number, size, and location of the voids in each specimen. Computer-recorded data of the traced areas provided a void surface in square millimeters for each specimen within the given frame surface.

Results

Table 1 shows void surfaces found in the eight series

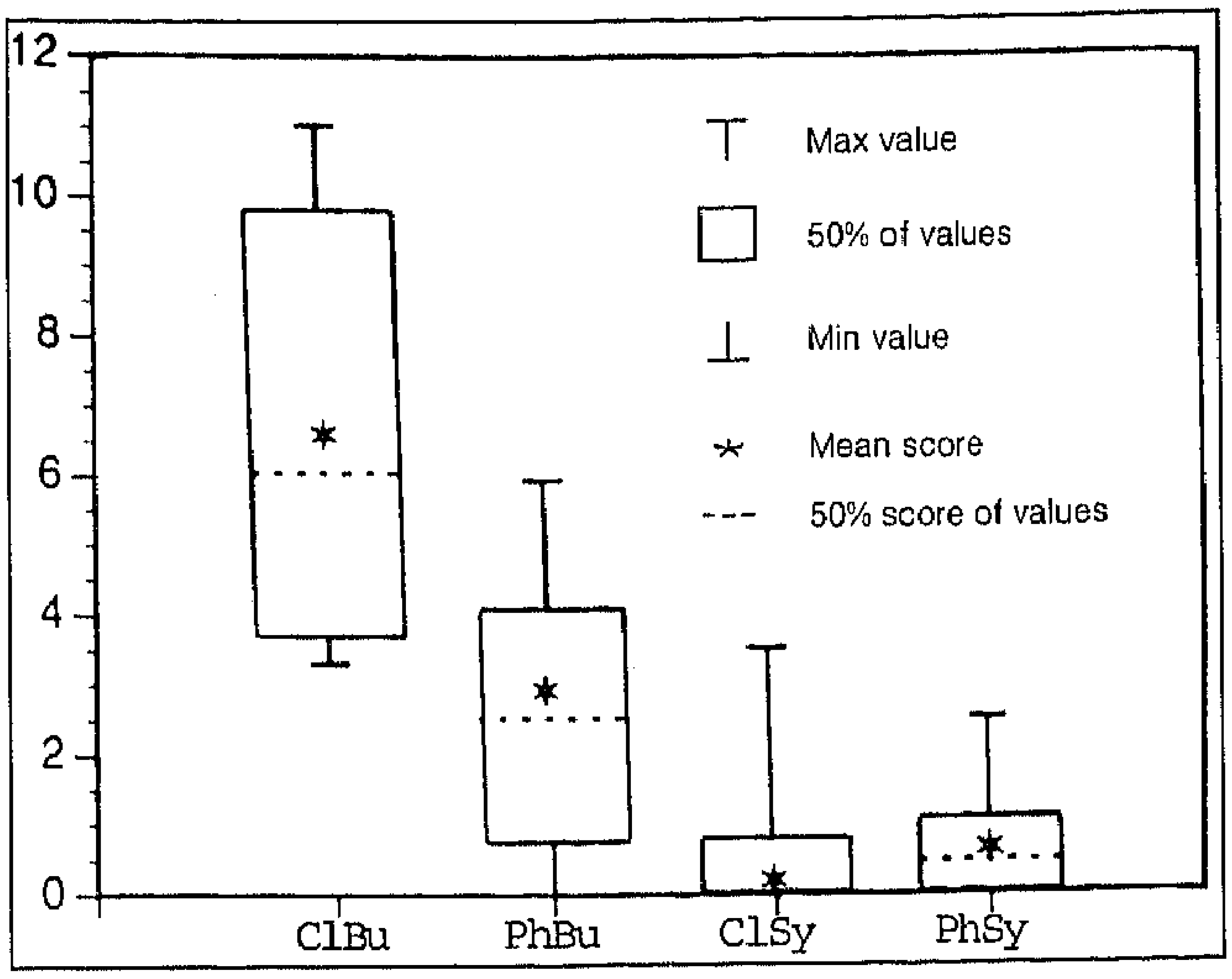

Fig 2 Percentages of void surface in the specimens (n = 40), distributed to the four combinations of two variables (application technique and core material): Clearfil core, bulk insertion (ClBu); Photo core, bulk insertion (PhBu); Clearfil core, syringe insertion (ClSy); Photo core, syringe insertion (PhSy).

within the given frame. Of a total of 40, 11 specimens appeared to have no detectable void surface. A minimal percentage of void surfaces was scored in the series with Clearfil core, syringe technique, and Radix post (ClSyRA). The highest percentage of void surfaces was scored in the series of chemically cured resin composite cores placed with the bulk insertion technique (7.4%). In 95% of the cores formed by the bulk insertion technique, a void surface was present. In contrast, 50% (10) of the buildups exhibited a void surface when the syringe technique was used.

The reliability of the observers was high. The deviation was 3% between observers 1 and 2, 1% between observers 1 and 3, and 2% between observers 2 and 3. The average SD was 5.8% with a measurement error of 4%. The results of the observers' scores are shown in Table 1. According to ANOVA statistical measurements, the influence of the variable application technique was found to be highly significant ($P = .0001$). Less significant was the influence of the combination application technique and core material ($P = .014$). Because influence of the variable post placement was found to be not significant, it is not shown in Fig 2.

Figure 2 presents a box plot of the percentages of void surface in the specimens (n = 40) distributed to the four combinations of two variables, core material (Cl and Ph) and application technique (Bu and Sy). A maximum of 11% of void surface was scored with the combination of a chemically cured resin composite and the bulk insertion technique. In Figs 3a to 3d, the different techniques and core materials are presented, including post placement.

Discussion

Quantifying the percentage of incorporated air in the resin composite core material is restricted in this study to a two-dimensional image within a given frame surface. Post placement seemed not to influence the presence of voids. Unlike some other studies,[5-9] the present study used a setup reproducing a clinical situation.

Although porosity in resin composites leads to inferior mechanical characteristics of the material, especially deterioration of the marginal integrity, it also may reduce stress of the resin composite core restoration. The presence of some porosity is not per se disadvantageous.[10]

Initial differences in incorporated air between the two resin composite core materials used in this study may have resulted because the light-curing core material is homogeneously mixed by the manufacturer and the two-paste chemically cured resin composite is mixed by the dentist,[8] resulting in incorporation of air.

The application of resin composite core material with the bulk insertion technique in a clinical setup caused incorporation of air in 95% of the specimens. Also the largest void surface seen was detected in a specimen prepared by this technique. The syringe technique is, as shown in other studies,[5,7,9] a more appropriate technique to use. Although it was expected that post placement might be an obstacle to insertion of resin composite core material in a clinical situation, this hypothesis was not substantiated in this study.

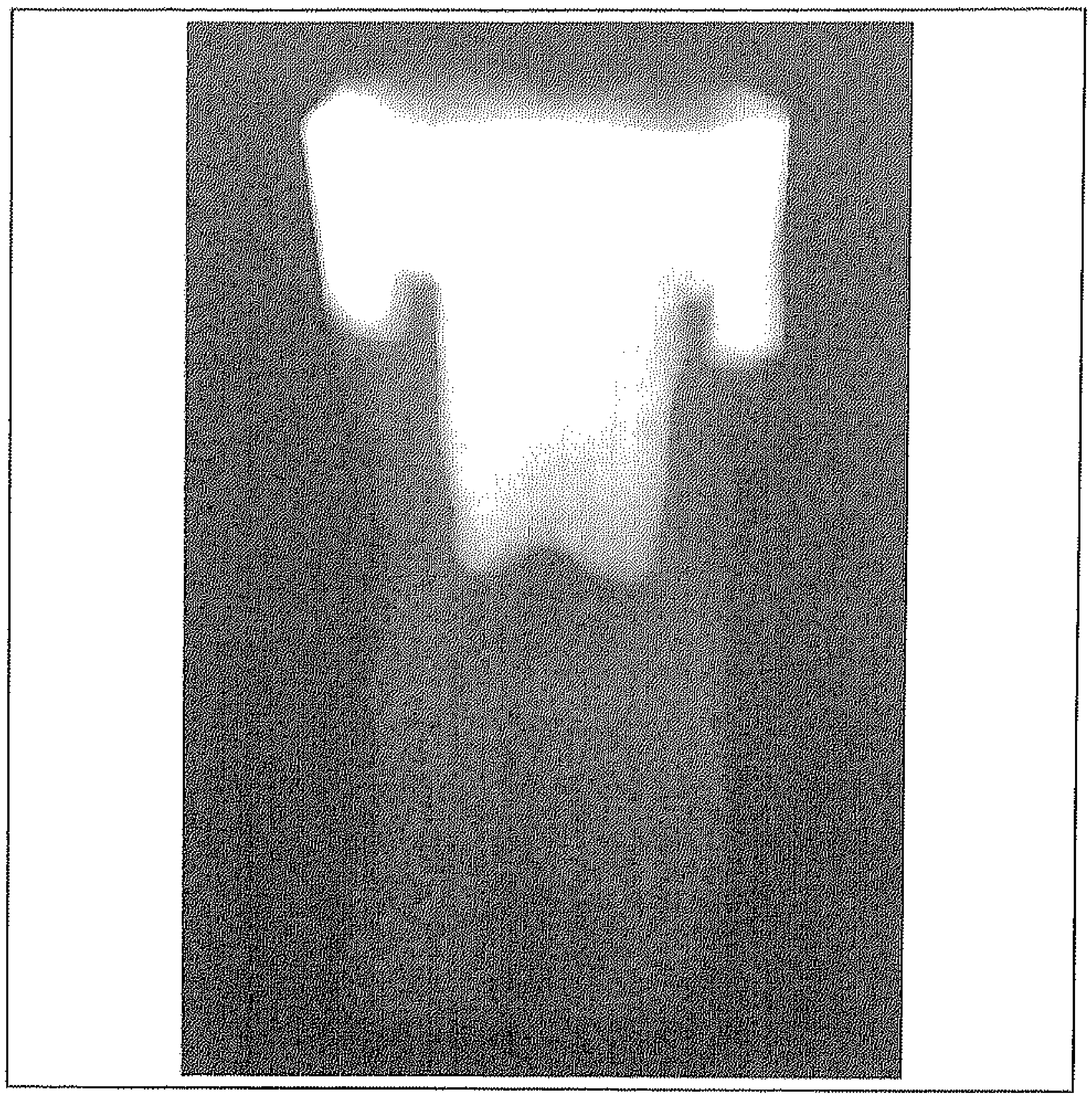

Fig 3a Syringe technique and Photo core.

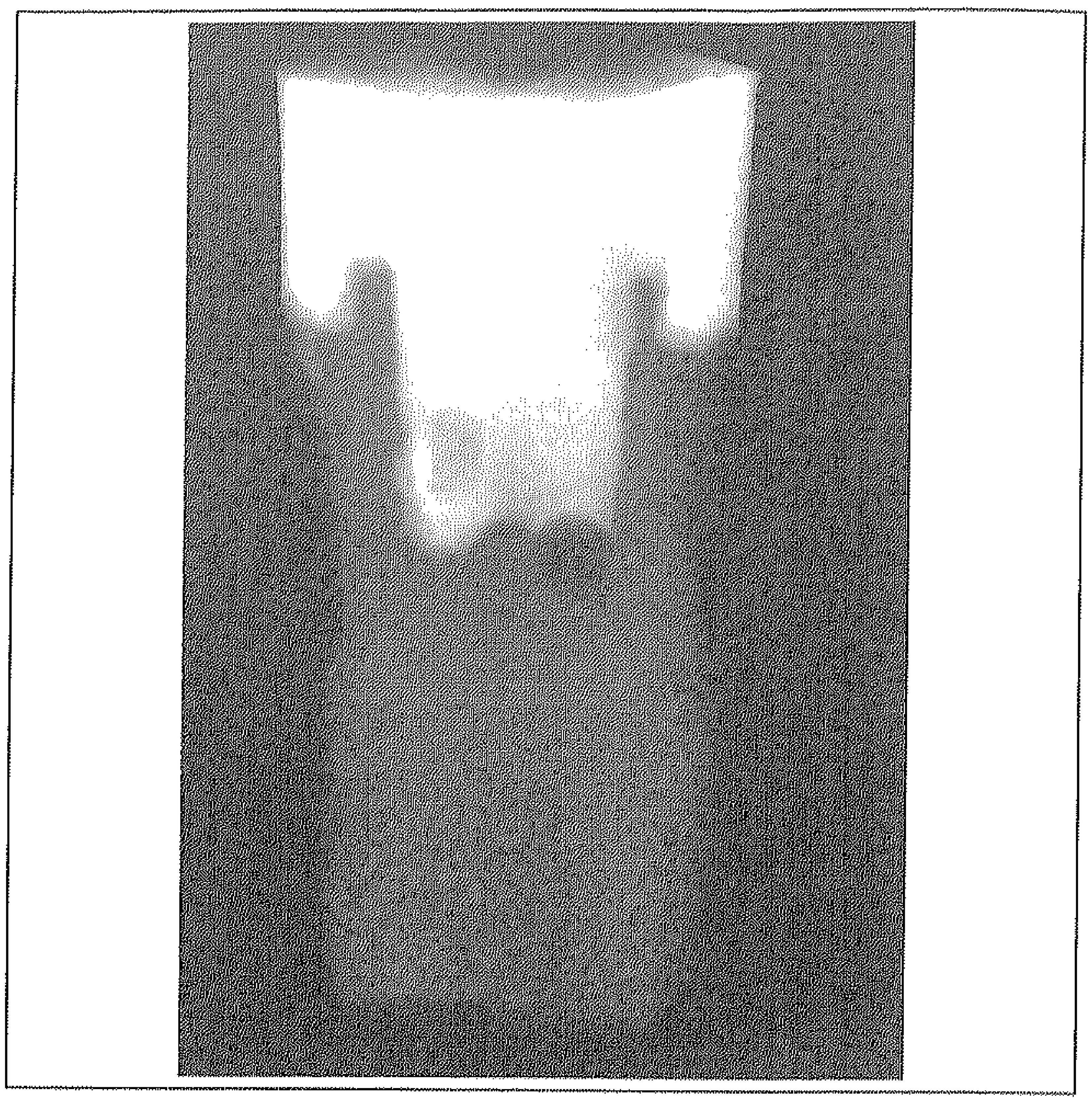

Fig 3b Bulk insertion technique and Clearfil core.

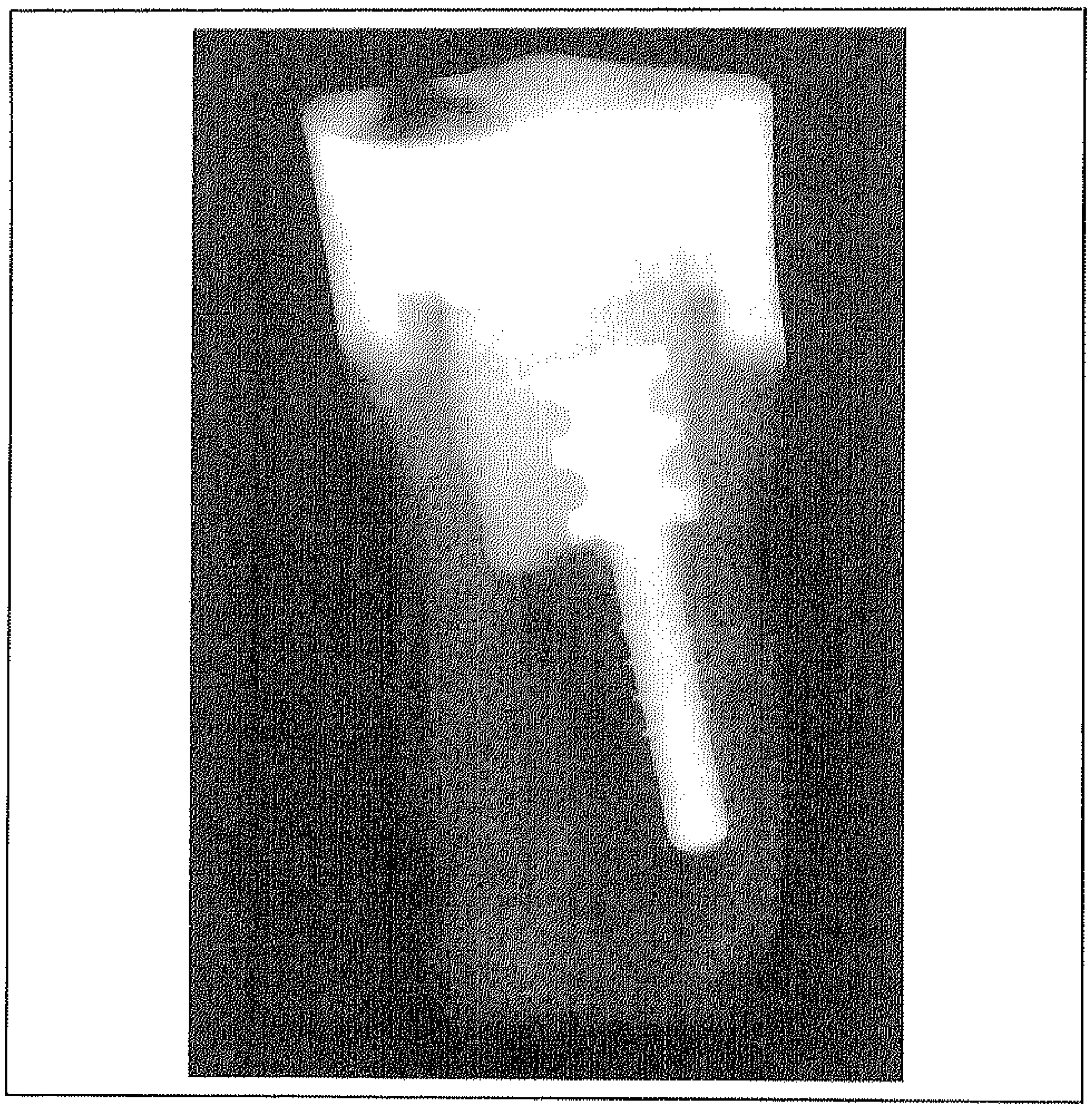

Fig 3c Syringe technique and Clearfil core with post placement.

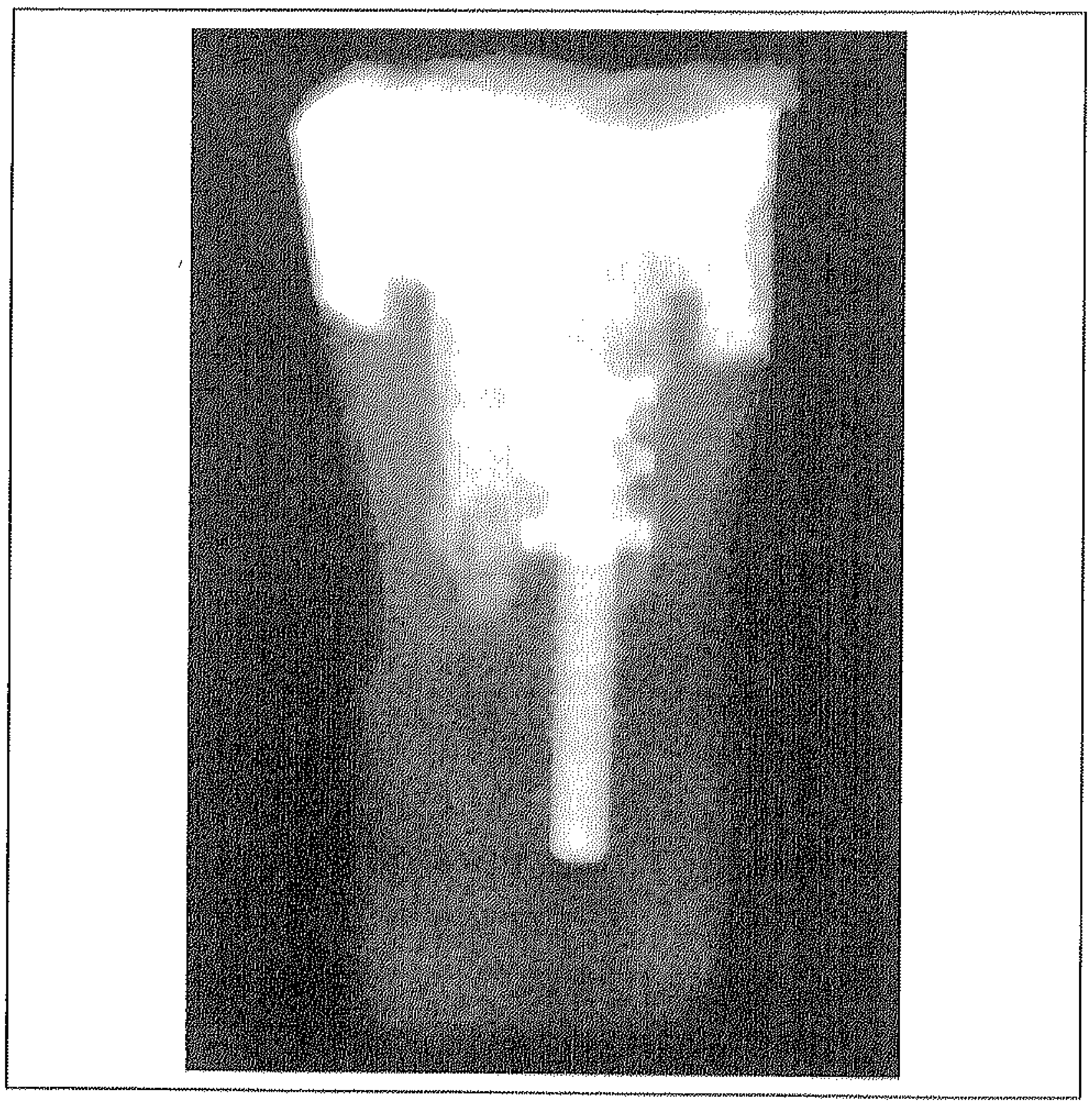

Fig 3d Bulk insertion technique and Photo core with post placement.

Conclusion

Within the limitations of this study, results indicated that, for resin composite core restorations, the resin composite should be inserted with a syringe into the tooth to minimize incorporation of air.

References

1. Hudis IS, Goldstein GR. Restoration of endodontically treated teeth. A review of the literature. J Prosthet Dent 1986;55:33–38.
2. Käyser AF, Leempoel PJB, Snoek PA. The metal post and composite core combination. J Oral Rehabil 1987;14:3–11.
3. Hunter AJ, Flood AM. The restoration of endodontically treated teeth. Part 3. Cores. Aust Dent J 1989;34:115–121.
4. Mentink AGB, Creugers NHJ, Meeuwissen R, Leempoel PJB, Käyser AF. Clinical performance of different post and core systems—Results of a pilot study. J Oral Rehabil 1993;20:577–584.
5. Gjerdet R, Hegdahl T. Porosity of resin filling materials. Acta Odontol Scand 1978;36:303–307.
6. Gotfredsen P, Horsted P, Kragstrup J. Porosity of restorative resins. Scand J Dent Res 1983;91:312–315.
7. Medlock JW, Zinck JH, Norling BK, Sisca RF. Composite resin porosity with hand and syringe insertion. J Prosthet Dent 1985; 54:47–51.
8. Finger W, Jorgensen KD. Porosität von Komposit Füllungsmaterialien. Schweiz Monatsschr Zahnheilkd 1977;87:482–489.
9. Fischel HF, Tay WM. Effect of manipulative techniques on porosity in composite resin [abstract 432]. J Dent Res 1977;56(Special issue A).
10. Alster D, Feilzer AG, de Gee AG, Mol A, Davidson CL. The dependence of shrinkage stress reduction on porosity concentration in thin resin layers. J Dent Res 1992;71:1619–1622. □