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REPLANTATION OF EXTRACTED MOLARS

A RADIOGRAPHIC AND HISTOLOGICAL STUDY

by

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INTRODUCTION

Endodontic treatment of permanent molars with necrotic pulps and complicating periapical infections is often impossible to carry out adequately due to inaccessible root canals. Extraction and extraoral root-filling with subsequent replantation has been advocated in the management of these cases, *Bielas et al.* (1959), *Deeb et al.* (1965).

In replantation of teeth the main problem is resorption. This problem has been studied by *Hammer* (1934, 1937) in experiments on dogs. He emphazised the significance of the periodontal membrane as an important factor influencing the mode of healing. He observed that the healing might occur as a primary union between the alveolar part of the periodontal membrane and the part which remains attached to the tooth without subsequent resorption. On the other hand, if the periodontal membrane was removed, the root showed resorption and deposition of bone tissue was seen. This process of ankylosis continued until the tooth was lost. The lifespan of a replanted tooth was found to be directly proportional to the area of the periodontal membrane which remained attached to the tooth, *Hammer* (1937).

Similar results have been found in experiments on dogs and monkeys by *Löe & Waerhaug* (1961).

In human material *Heiss* (1944) found no difference with regard to the degree of resorption whether the periodontal membrane was retained or removed before replantation. Krömer, however, in a histological examination of three replanted human teeth, confirmed the results of *Hammer* and *Löe & Waerhaug*.

Bielas et al. (1959) have reported a follow-up study of 943 replantations of premolars and molars in humans. With five years observation period a total of 59 % successful cases were found. In 28 cases replanted without periodontal membrane nine teeth (31 %) were lost immediately after the operation. In 915 teeth replanted with preserved periodontal membrane only 13 teeth were lost (1 %).

Deeb et al. (1965) replanted 274 teeth for endodontic purpose in humans. It was found that preservation of the periodontal membrane increased the number of successful cases.

The aim of the present investigation was to study radiologically and histologically the long term results after replantation of molars with efforts taken to preserve the periodontal membrane and while using a uniform technique.

MATERIAL AND METHODS

In a preliminary report *Emmertsen* (1956) published a short term study of 92 extracted and replanted molars. The present study is a long term investigation of this material supplemented with information on eight more replanted teeth. All replantations were performed by one of the authors (E.E.) during the period of years 1949—58 and were followed for a maximum of 13 years.

Material. The replantations were carried out on molars with periapical infections, where conventional root-filling was found impossible because of inaccessible canals.

The material is comprised of 100 immediate replanted molars in 90 patients (55 women and 45 men).

The age distribution and the distribution according to tooth type are shown in Table I and II.

Methods. All extractions and replantations were carried out under block anaesthesia. The gingival margin was loosened and the tooth extracted with forceps with gentle luxation and rotatory movements to avoid root fracture. The direction in which the

Table I

Age at time of replantation grouped in ten years interval

Age	10—19	20—29	30—39	40—49	50—59
Number	11	44	27	14	4

Table II

Distribution of teeth according to location

Tooth	*) 6—6	7—7	6+6	7+7	+8
Number	54	27	14	4	1

*) The figures indicate the region according to Haderup's nomenclature: — denotes the lower jaw. If the sign is placed to the right of the figure (1+, for example), the right side is indicated, and vice versa (Haderup, 1887).

tooth was removed was noted in order to replace it in the same direction.

After extraction the tooth was placed in lukewarm physiological saline. Curettage of the periapical area was undertaken if a cyst or a granuloma was diagnosed radiographically. The socket was gently packed with iodoform gauze to prevent formation of a clot and to prevent contamination with saliva. The wound was covered with gauze sponges.

During the subsequent treatment the tooth was held in the forceps. While spraying with physiological saline the apical part of the root was resected with a vulcarbo disc. A Beutelrock drill was introduced into the canal from the apical root end and advanced to the pulp chamber, or at least to the level of the cemento-enamel junction. The canals were then rinsed with chloramine, dried and retrograde filled with kloroperka® and guttapercha points. In 22 cases retrograde silver amalgam filling was employed in addition to make the sealing of the apex as effective as possible. During the root filling procedure the root surface was kept moist with a sponge soaked in saline. The replantation of the tooth was occasionally difficult and some cases needed tapering of the roots by grinding, particularly the

lingual root of upper molars. In a few cases attempts to replant the tooth were unsuccessful. To fixate the replanted tooth a piece of lead-foil from a dental x-ray film was fitted closely over the crown, adjacent teeth and 3—4 mm of the facial and lingual gingiva and cemented with surgical cement. The masticatory pressure helped to keep the tooth in right position in the socket.

Each patient received one injection of 100.000 units sodium penicillin + 300.000 units procain penicillin before the extraction. The fixation was removed after eight days.

Radiographic examination: Radiographic examination was performed up to thirteen years after replantation. In the evaluation of the radiograms the same radiographic criterias were used with regard to 1) root resorption and 2) healing of the periapical infection as proposed by *Andreasen & Hjørting-Hansen* (1966 a).

1) *Resorption classification:*

Group 1. *No resorption.* This group was radiographically characterized by a normal lamina dura (Fig. 3, 6) and no signs of resorption.

Group 2. *Replacement resorption* was radiographically characterized by a continuous replacement of lost root substance with bone and no radiolucency in relation to the resorption area (Fig. 24).

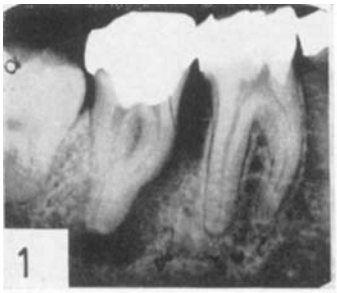
Group 3. *Inflammatory resorption.* In this group periradicular radiolucency in relation to areas with resorption of the root substance was seen (Fig. 15, 18, 21).

Figs. 1—3. Complete healing without resorption or periapical inflammation. Root-filling with guttapercha. Fig. 1. Before replantation of 7—. Fig. 2. One year after replantation. Fig. 3. Condition after four years.

Figs. 4—6. Complete healing of 6—. Retrograde root-filling with amalgam. Fig. 4. Immediately after replantation. Fig. 5 and 6. Condition after two and ten years; no sign of resorption or periapical inflammation.

Figs. 7—9. Slight periapical inflammation but no root resorption of 6—. Fig. 7. Time at replantation. Fig. 8 and 9. Nine and eleven years after replantation — notice widening of the periodontal membrane around the apex of the mesial root.

Figs. 10—12. Marked periapical inflammation, but no root resorption of 6—. Fig. 10. Immediately after replantation. Fig. 11 and 12. Condition after one and seven years.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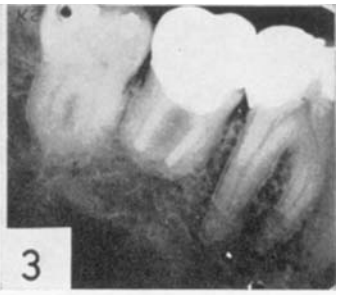
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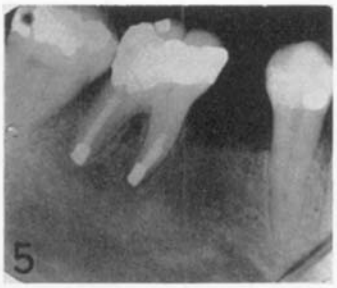
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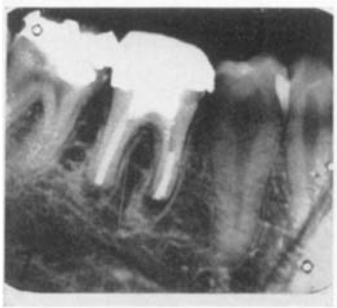

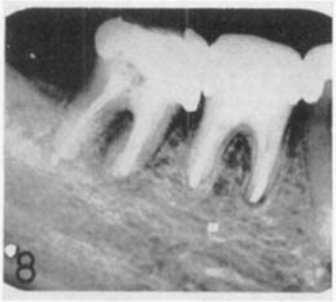
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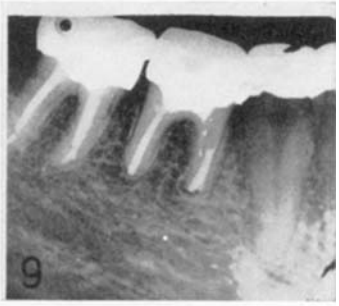
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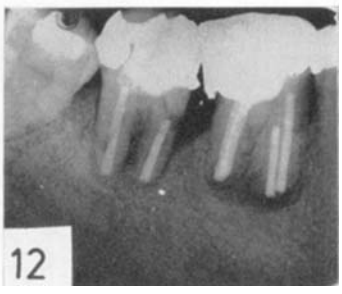
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2) *Classification according to healing or non-healing of the periapical inflammation:*

If re-establishment of a normal lamina dura was found around the apex, the tooth was registered as exhibiting periapical healing. If a widening of the periodontal space (Fig. 9) or a radiolucent area was seen around the apex (Fig. 12) the tooth was placed in the periapical inflammation group.

Histologic examination: Six teeth were removed in varying periods from six months to ten years after replantation and were examined histologically. In three of these cases the teeth were removed with surrounding bone, in the other cases the tooth alone was extracted. Immediately after removal the specimen was fixed in neutral buffered formalin and was decalcified in formic acid/sodium citrate. Four teeth were embedded in celloidin, and in two cases double embedding was used. The specimen was sectioned completely and every fifth section was stained with hemotoxylin and eosin.

RESULTS

Radiographic evaluation

The results according to this evaluation are shown in Table III. In group 1 (no resorption) teeth with observation period exceeding one year were registered separately.

Thirty-four percent showed no resorption and periapical healing with an observation period exceeding one year. Seventeen percent showed no resorption, but demonstrated periapical inflammation. Apart from one case the teeth in the present study showed no resorption in the follow-up period, if resorption had

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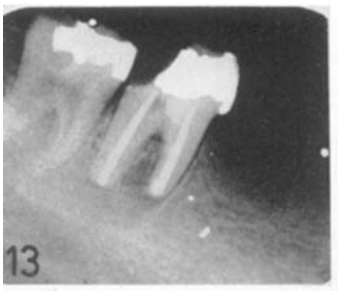
Figs. 13—15. 6— demonstrating moderate inflammatory resorption. Fig. 13. Immediately after replantation. Fig. 14. Condition after six months. Fig. 15. One and a half year after — notice inflammatory resorption around the distal root.

Figs. 16—18. Marked periapical inflammation and inflammatory resorption of —6. Fig. 16. Before replantation. Fig. 17. After replantation. Fig. 18. Five years after replantation.

Figs. 19—21. Marked inflammatory resorption of 6—. Fig. 19. Immediately after replantation. Fig. 20 and 21. Condition two and four years after.

Figs. 22—24. Replacement resorption of —6. Fig. 22. Before, and fig. 23 immediately after replantation. Fig. 24. Resorption and replacement of root substance with bone seven years after replantation.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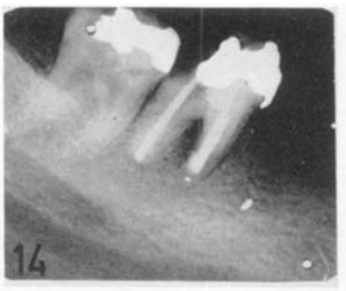
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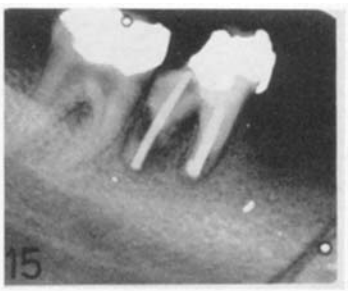
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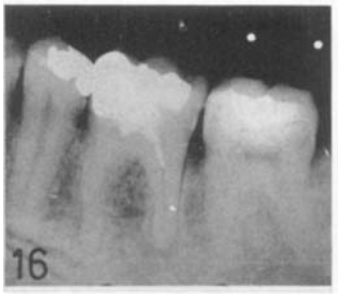
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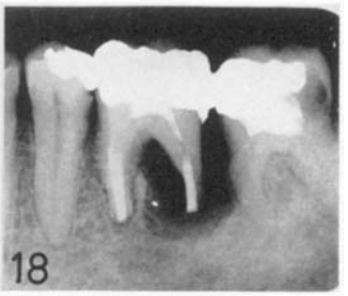
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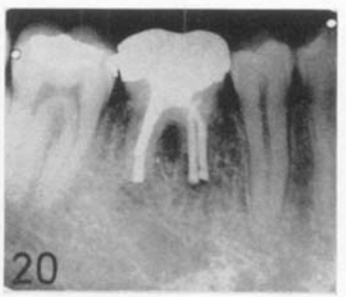
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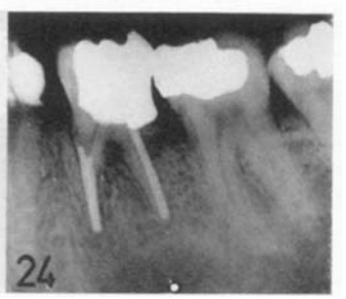
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Table III

Roentgenologic evaluation of the material

		Number
No resorption (Group 1)	Periapical healing	39*)
	Periapical inflammation	29**)
Replacement resorption (Group 2)	Periapical healing	2
	Periapical inflammation	2
Inflammatory resorption (Group 3)	Periapical healing	8
	Periapical inflammation	19
Immediate loss		1
	Total	100

*) Thirty-four of these cases were followed for more than one year.

**) Seventeen of these cases were followed for more than one year.

not been present in the first year. Only 4 % of the teeth showed replacement resorption, while 27 % demonstrated inflammatory resorption, and in this group most cases also showed periapical inflammation.

In Table IV the results of the radiographic evaluation are related to sex, age, location of teeth, type of root-filling, presence of periapical radiolucency at the time of replantation and whether the extraction or replantation procedure was difficult. A chi-square test was used in order to correlate the clinical informations with the radiographic findings. In the statistical analysis group 2 was excluded because of the small number of teeth in these group. Teeth with periapical radiolucency at the time of replantation were more often found in group 1 (no resorption) than in group 3 (inflammatory resorption) $0.005>p>0.001$. With regard to periapical healing, no significant difference was found between cases with or without periapical radiolucency at time of replantation.

In the age group 10—30 years inflammatory resorption and periapical inflammation were found more frequently as compared with older age groups $0.05>p>0.025$. Teeth with retrograde amalgam root-filling demonstrated more often inflammatory re-

Table IV

Result of radiographic evaluation related to various factors

		Group 1*)		Group 2		Group 3	
		Peri-apical healing	Peri-apical inflam-mation	Peri-apical healing	Peri-apical inflam-mation	Peri-apical healing	Peri-apical inflam-mation
Sex	♂	11	7	1	2	4	11
	♀	23	10	1	0	4	8
Age	30 years	13	11	0	2	7	13
	30 years	21	6	2	0	1	6
Location of teeth	6—6	19	8	0	1	6	8
	7—7	7	7	2	0	0	7
	6+6	6	0	0	1	1	1
	7+7	1	2	0	0	1	0
	8+8	1	0	0	0	0	0
Root-filling	Gutta percha	27	15	2	2	5	13
	Amalgam	7	2	0	0	3	6
Periapical radiolucency at time of replantation**)	+	24	15	1	0	1	11
	–	8	2	1	2	7	7
Difficult extraction or replantation***)	+	3	4	0	2	4	3
	–	28	13	2	0	3	14

*) Only teeth followed for more than one year are included.

**) In three cases information was not available.

***) In six cases information was not available.

sorption as compared with teeth filled with guttapercha, but the difference was not significant, $0.20>p>0.10$.

With regard to sex, location of teeth and difficulty of extraction or replantation procedure no significant difference was found, when this clinical information was correlated with the radiographic findings.

In six cases part of the buccal alveolar bone was accidentially removed during extraction. On follow-up two of these cases demonstrated resorption, while the remaining showed no resorption.

Observation period

In Fig. 28 the entire material is tabulated according to observation period. In the histogram the first bar represents the total number of teeth examined in the first year. The black area indicates extracted or lost teeth, the dotted area indicates teeth with replacement or inflammatory resorption. The next bar in the histogram represents the number of teeth examined in the second observation year. Teeth extracted during the first year or teeth with observation period shorter than two years are not included.

In one case primary healing did not occur because of infection, and the tooth was removed after six weeks. Nineteen teeth were removed due to periapical inflammation (9 cases) or root resorption (10 cases).

Fig. 25. The mesial root of —7 removed after ten years, demonstrating periapical healing and no resorption. Orig. magnif. × 8.

A. Immediately after replantation.

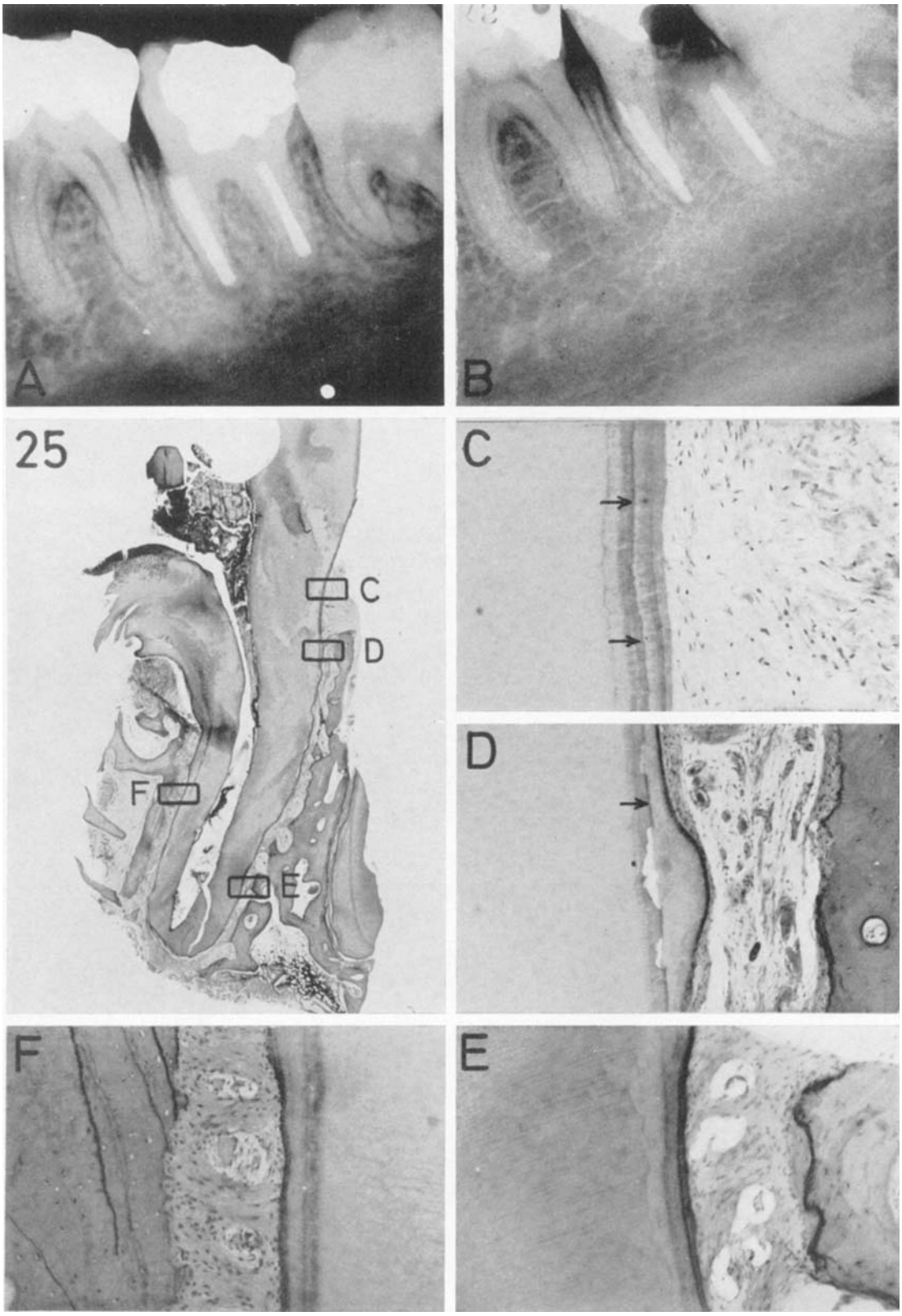
B. No radiographic sign of resorption after ten years.

C. Normal cementum and periodontal membrane. Note basophilic line separating cementum formed before and after replantation (arrow fig. C and D). Orig. magnif. × 75.

D. New cementum formed after minor surface resorptions. Orig. magnif. × 75.

E. More extensive surface resorption repaired with a thick layer of cementum. Orig. magnif. × 75.

F. Normal periodontal membrane. Orig. magnif. × 75.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Histological evaluation

No resorption. In one case a tooth was removed ten years after replantation due to caries; no radiographic sign of resorption was seen (Fig. 25). The histological examination revealed a normal periodontal membrane around the tooth with collagen fibres inserting in the cementum and the alveolar bone (Fig. 25 F). In many areas of the root surface reversal lines suggestive of previous superficial cementum resorption could be seen, particularly in the middle and the apical third of the root, but all of these areas were repaired with a thick layer of new cementum (Fig. 25 D, E). This cementum formed after the replantation was separated from previous formed cementum by a thin basophilic line (Fig. 25 C, D). Coronal to the level of the alveolar bone no sign of previous resorption was seen (Fig. 25 C).

Inflammatory resorption. The remaining five cases demonstrated radiographic signs of inflammatory resorption. In these cases bowl shaped areas of resorption involving both cementum and dentin were seen in relation to areas with inflammation in the periodontal membrane (Fig. 26). Remnants of necrotic pulp tissue were found in all cases in the root canal (Fig. 27 E). All teeth showed areas with normal cementum and periodontal membrane, especially in the coronal part of the root (Fig. 26 C, 27 C). Most new coronal cementum had been formed without preceding resorption, and this cementum was more eosinophilic (Fig. 26 C). In other areas surface resorption was repaired with new cementum (Fig. 26 D).

Fig. 26. 6— demonstrating inflammatory resorption. Tooth removed after five months. Orig. magnif. × 6.

A. Radiogram immediately after replantation.

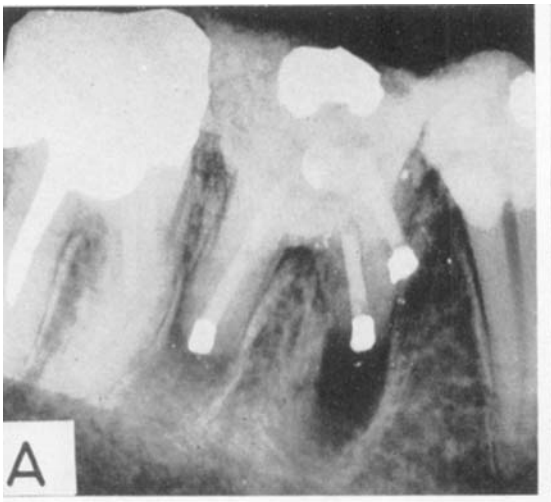
B. Radiogram at the time of removal.

C. Normal cementum. Orig. magnif. × 75.

D. Surface resorption repaired with new cementum — note the more eosinophilic cementum formed after replantation. Orig. magnif. × 75.

E. Area with active resorption. Orig. magnif. × 30.

F. Granulation tissue in relation to resorbed root surface. Orig. magnif. × 75.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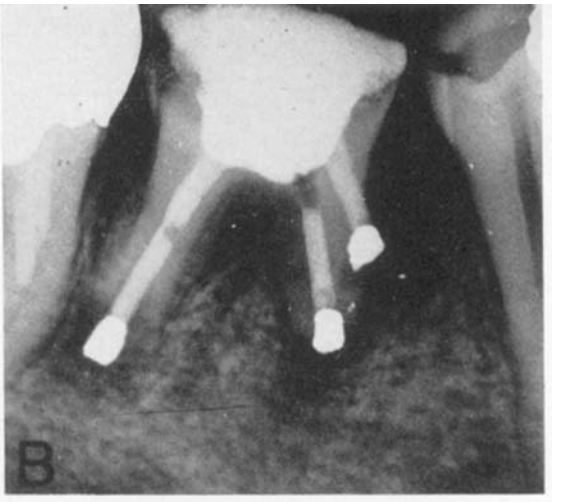
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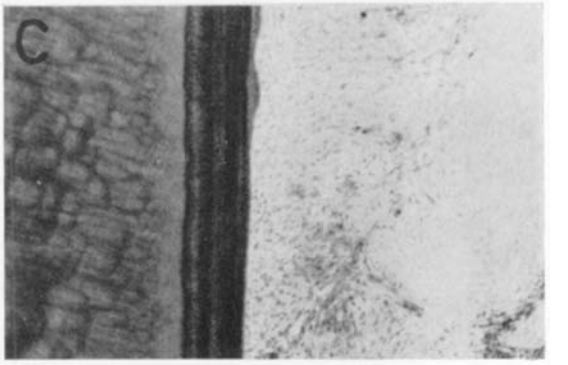
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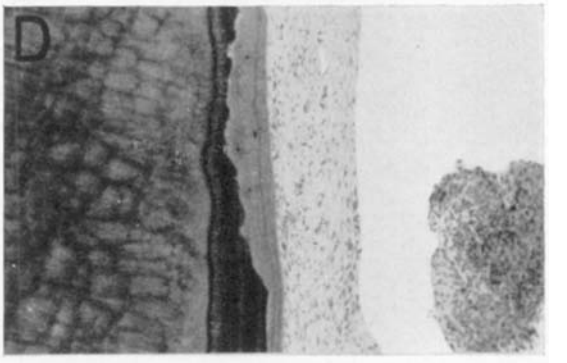
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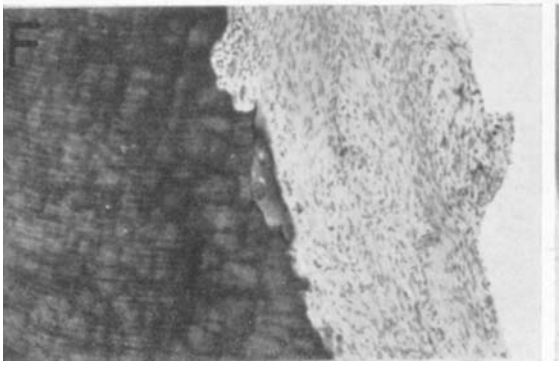
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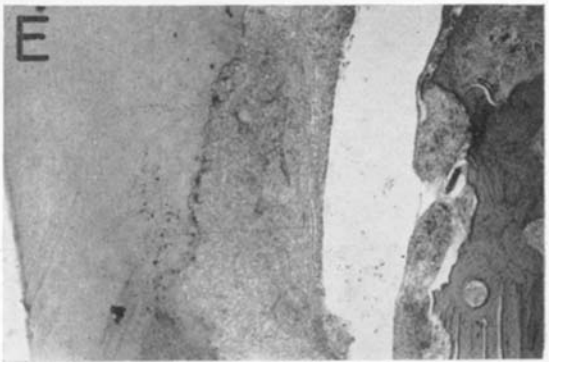
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DISCUSSION

In the evaluation of replanted molars two main factors should be considered. 1. The healing of the periapical lesion. 2. Damage introduced to the tooth and surrounding tissues by the replantation procedure.

Ad. 1. Periapical inflammation is influenced by the quality of the root filling. In this material 49 % of the replanted teeth showed periapical inflammation. The high number of insufficient periapical healings is surprising. The explanation for this could be an opening of infected dentinal tubules after resection of the apices. In a study of anterior teeth replanted after accidental loss *Andreasen & Hjørting-Hansen* (1966 a) found periapical inflammation in 9 % and 63 % respectively in group 1 and group 3. In the present study group 1 and group 3 showed periapical inflammation in 33 % and 70 %. The more frequent occurrence of periapical inflammation in group 1 found in this study is probably explained by an infected root canal at the time of replantation.

Ad. 2. In the present material no resorption (group 1) was found in 67 % of the replanted teeth (51 % with observation period exceeding one year). In the replantation procedure, usually lasting 30—60 min., efforts were made to keep the periodontal membrane intact. In a study on replantation of anterior teeth *Andreasen & Hjørting-Hansen* (1966 a) found no resorption in 72 % of the replanted anterior teeth, when the extraoral period varied from 0—60 min. Based upon these findings no difference seems to exist between the prognosis for replanted anterior teeth and molars, when the extraoral period is identical.

Deeb et al. (1965) found more frequently resorption in replant-

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Fig. 27. 6— demonstrating inflammatory resorption. Tooth removed five months after replantation. Orig. magnif. × 5.

A. Condition before replantation.

B. Time of removal.

C. Normal cementum. Orig. magnif. × 75.

D. Surface resorption of cementum. Orig. magnif. × 75.

E. Active resorption in the apical area. Orig. magnif. × 75.

F. Necrotic pulp tissue in the root canal. Orig. magnif. × 195.


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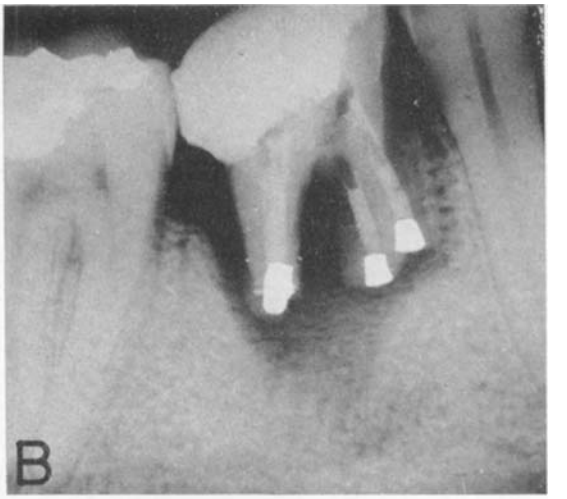
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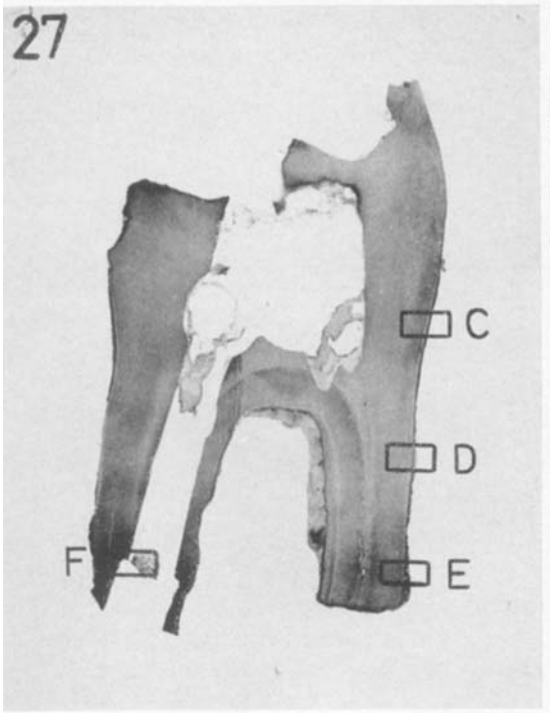
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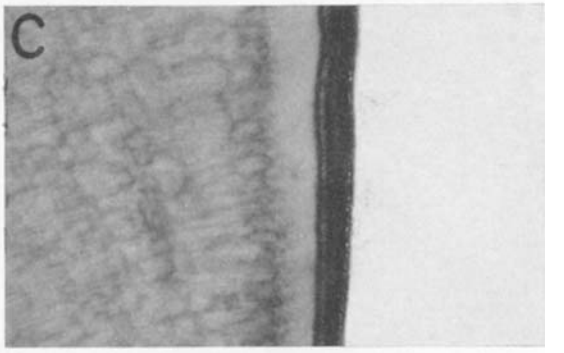
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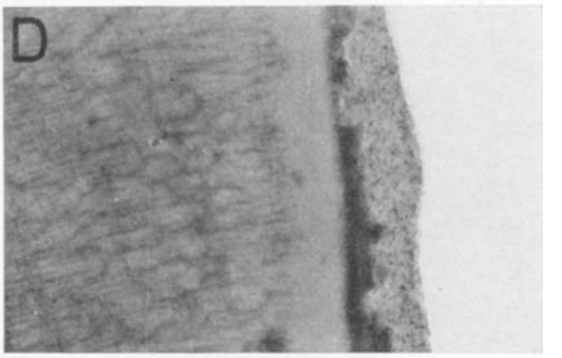
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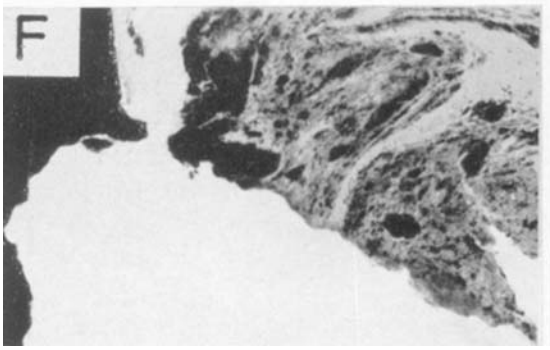
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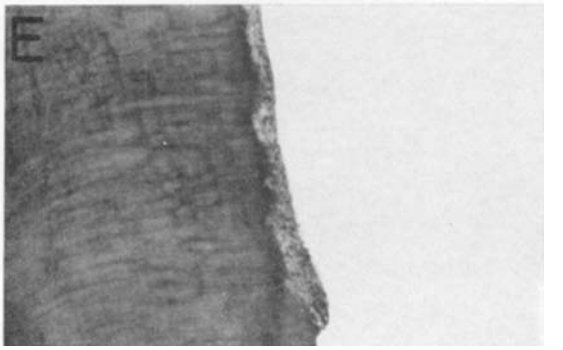
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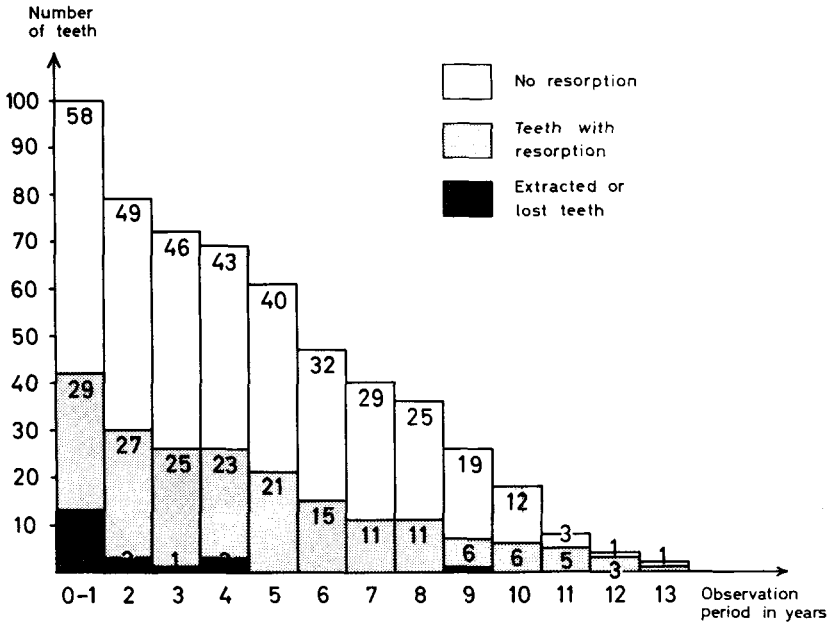
FIG. 28. Loss of teeth during observation period.



ed teeth, when amalgam was used as root-filling material as compared with guttapercha. The present study seems to support this finding.

The inflammatory resorption type was found in 27 % of the present material. This resorption type might be explained by the presence of necrotic pulp tissue in the root canal or bacteria in the dentinal tubules. This resorption type was found in 39 of 110 replanted teeth (35 %) by *Andreasen & Hjørting-Hansen* (1966 a). There is thus a good agreement between the present study and the study of *Andreasen & Hjørting-Hansen*. The influence of necrotic pulp tissue in the root canal might also explain the high frequency of periapical inflammation found in this group.

Replacement resorption was found in only 4 % of the present cases, while this resorption type was seen in 44 out of 110 teeth (40 %) in Andreasen & Hjørting-Hansen's study. The difference between the frequencies of replacement resorption in the two studies cannot be explained at the present time.

Only 1 % of the teeth was immediate failures; this is the same percentage as found by *Bielas et al.* (1959). As in the present study *Bielas et al.* (1959) and *Deeb et al.* (1965) found no correlation between the survival rate of the replanted teeth and location of teeth.

With regard to root resorption a comparison between the present material and the study of *Bielas et al.* (1959) could not be made because these authors did not register minor resorptions.

The histological findings indicate that the replantation procedure damages the periodontal membrane and cementum, especially in the middle and the apical third of the root, resulting in a superficial resorption of the cementum (surface resorption), which after some time is repaired with new cementum. The same type of resorption was described by *Krömer* (1952) and by *Andreasen & Hjørting-Hansen* (1966 b) in a histological study of teeth replanted after accidental loss.

The inflammatory resorption is most probably caused by necrotic or infected material in the root canal as proposed by *Andreasen & Hjørting-Hansen* (1966 b). Areas with remnants of necrotic pulp tissue were found in all teeth examined in this study.

When the replantation procedure is evaluated as an endodontic method it should be emphasized, that only 34 % of the replantations in this study were found to be successful (with no resorption and satisfactory periapical healing). On the basis of this finding it seems reasonable to use replantation only in the endodontic treatment of permanent molars with periapical infections, when it is impossible to carry out an adequate conservative root-filling or a root resection.

SUMMARY

The present investigation is a clinical and radiographic study of 100 molars with periapical infections replanted after extraoral root-filling. The maximum observation period was thirteen years.

The radiographic evaluation revealed that 34 % of the replanted molars with a minimum observation period of one year showed no sign of resorption and healing of the periapical in-

fection. The remaining cases showed either root resorption or lack of healing of the periapical inflammation.

Teeth with periapical radiolucency at the time of replantation demonstrated a significant lower frequency of root resorption. In patients below the age of 30 years inflammatory resorption and periapical inflammation were found more frequently as compared with older age groups.

Six teeth were examined histologically. One tooth showed normal periodontal conditions, while the others demonstrated root resorption of inflammatory origin.

RÉSUMÉ

RÉIMPLANTATION DE MOLAIRES EXTRAITES
ETUDE RADIOLOGIQUE ET HISTOLOGIQUE

Le présent travail est une étude clinique et radiographique faite sur 100 molaires présentant une infection périapicale et réimplantées après obturation extra-buccale des canaux. La période d'observation maximum a été de treize ans.

L'étude radiographique a révélé que pour 34 % des molaires réimplantées, avec une période d'observation minimum d'un an, on ne constatit pas de signes de résorption, mais au contraire une guérison de l'infection périapicale. Dans les cas restants, on constatait soit une résorption radiculaire, soit l'absence de guérison d l'inflammation périapicale.

Pour les dents présentant au moment de la réimplantation une zone périapicale radioclaire, la fréquence des résorptions radiculaires se révélait significativement moins élevée. Chez les patients âgés de moins de 30 ans, des signes de résorption inflammatoire et d'inflammation périapicale ont été constatés plus souvent que chez les patients plus âgés.

L'étude histologique de six dents a été faite. Une de ces dents présentait un parodonte normal, alors que les autres présentaient une résorption radiculaire d'origine inflammatoire.

ZUSAMMENFASSUNG

REPLANTATION VON EXTRAHIERTEN MOLAREN
EINE RÖNTGENOLOGISCHE UND HISTOLOGISCHE UNTERSUCHUNG

Die vorliegende Arbeit befasst sich — klinisch und röntgenologisch — mit der Untersuchung von 100 Molaren mit periapikaler Infektion. Die Zähne wurden nach extraoraler Wurzelbehandlung replantiert. Die längste postoperative Beobachtung erstreckte sich über 13 Jahre.

Röntgenkontrollen zeigten, dass 34 % der replantierten Zähne nach Verlauf von mindestens einem Jahre keine Zeichen von Resorption, aber Ausheilung der periapikalen Infektion aufwiesen. Die restlichen Fälle zeigten entweder Wurzelresorption oder mangelvolle Heilung des Infekts. Zähne mit periapikaler Röntgenaufhellung zum Zeitpunkt der Replantation wiesen eine bedeutend niedrigere Wurzelresorptionsfrequenz auf. Bei Patienten unter 30 Jahren wurden entzündliche Resorption und periapikale Entzündung weit häufiger vorgefunden, als in höheren Altersgruppen.

Sechs Zähne wurden histologisch untersucht, einer von diesen wies normale Verhältnisse am Periodontium auf, während alle anderen Wurzelresorption entzündlichen Ursprungs zeigten.

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