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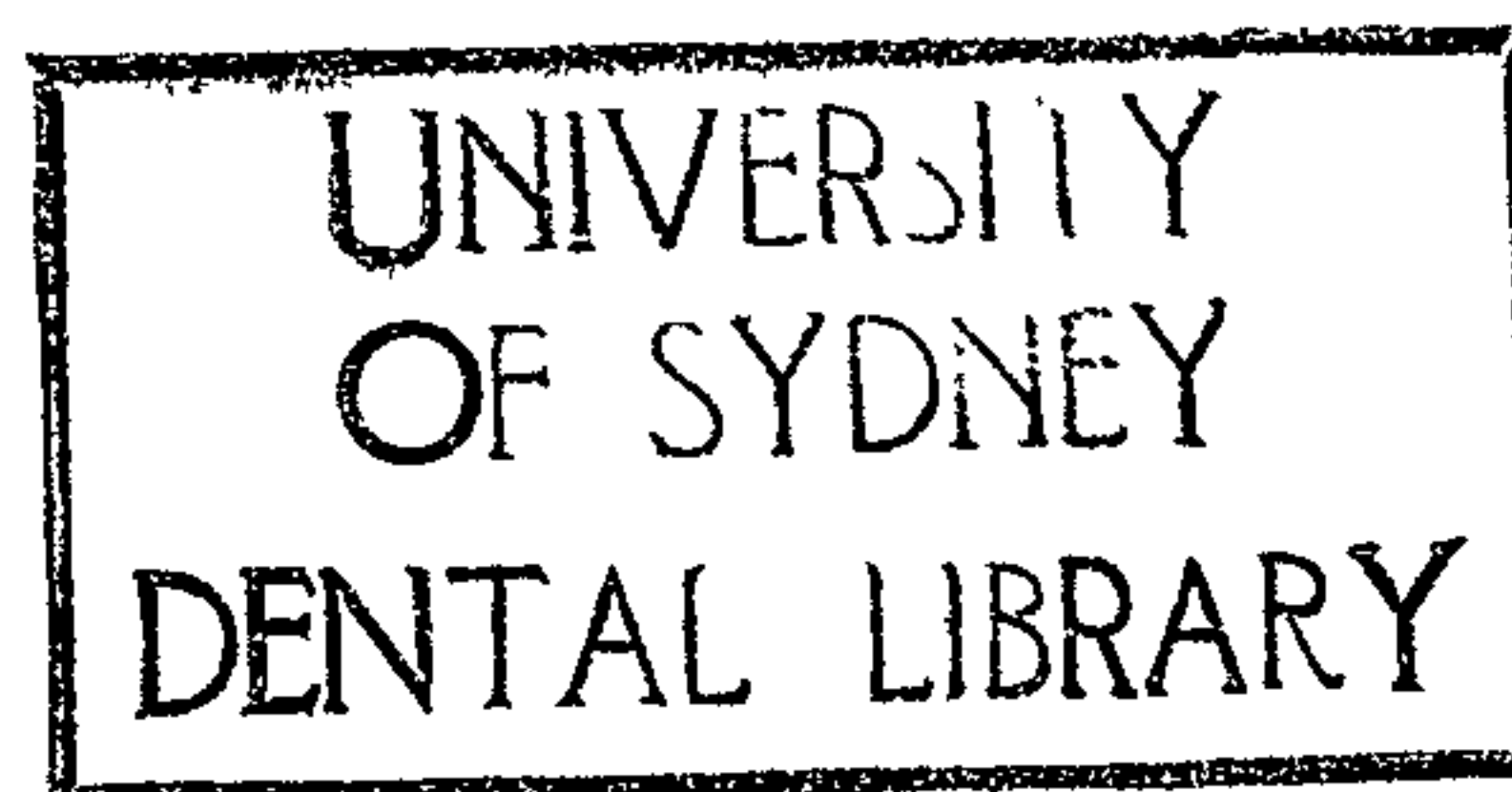
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EVALUATION OF TWO ELECTRONIC DEVICES
IN DETERMINING WORKING LENGTH IN ENDODONTICS

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Volume Two



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FIGURES

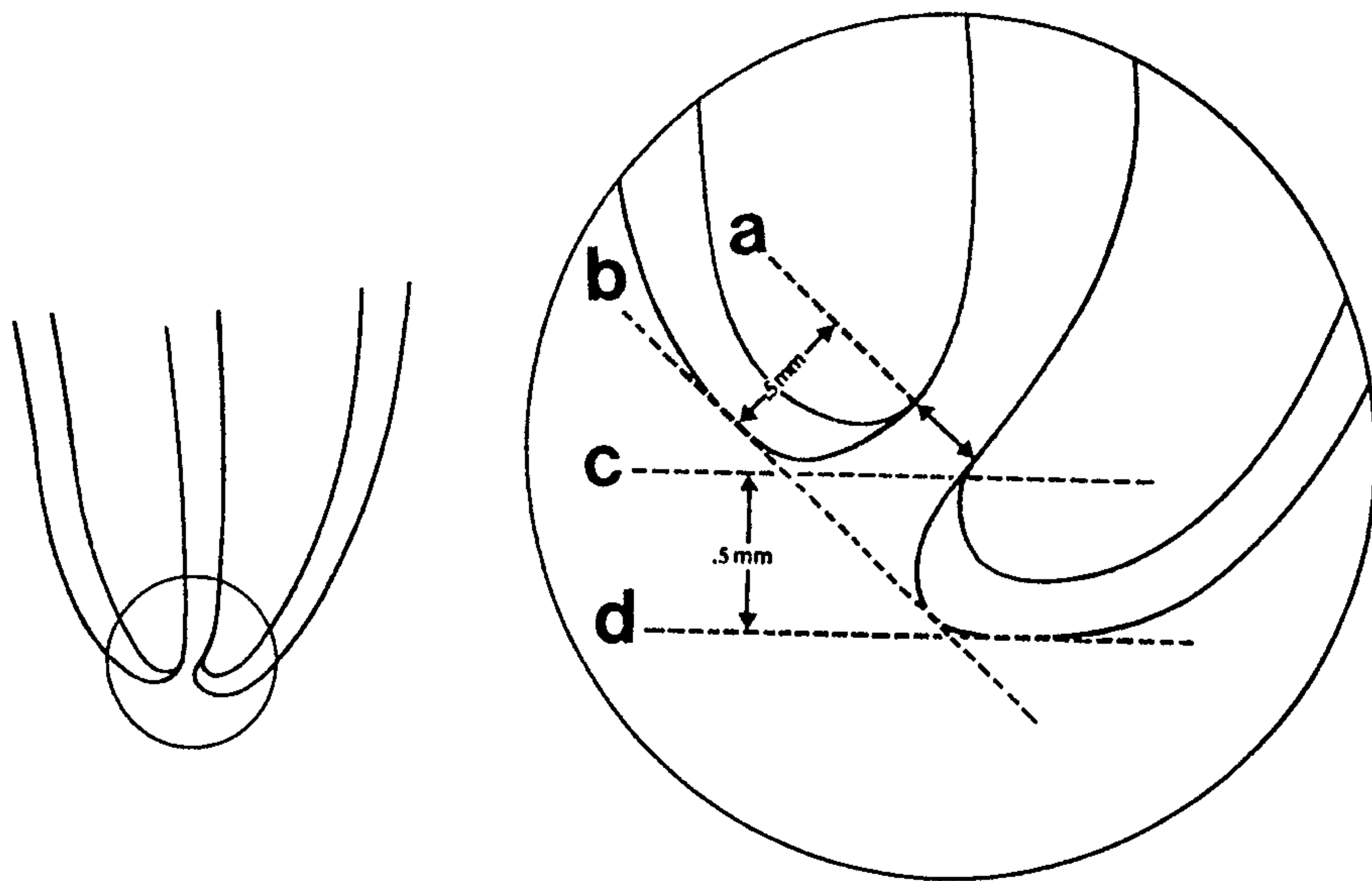


FIGURE 1.1

The cemento-dentinal junction where "a" represents the minor foraminal diameter, "b" the anatomic apex (the major foraminal diameter) and the distance between points "c" and "d" represents the probable location of the radiographic apex. The distance "a-b" is the cemental canal (from Gerstein 1983 p.53).

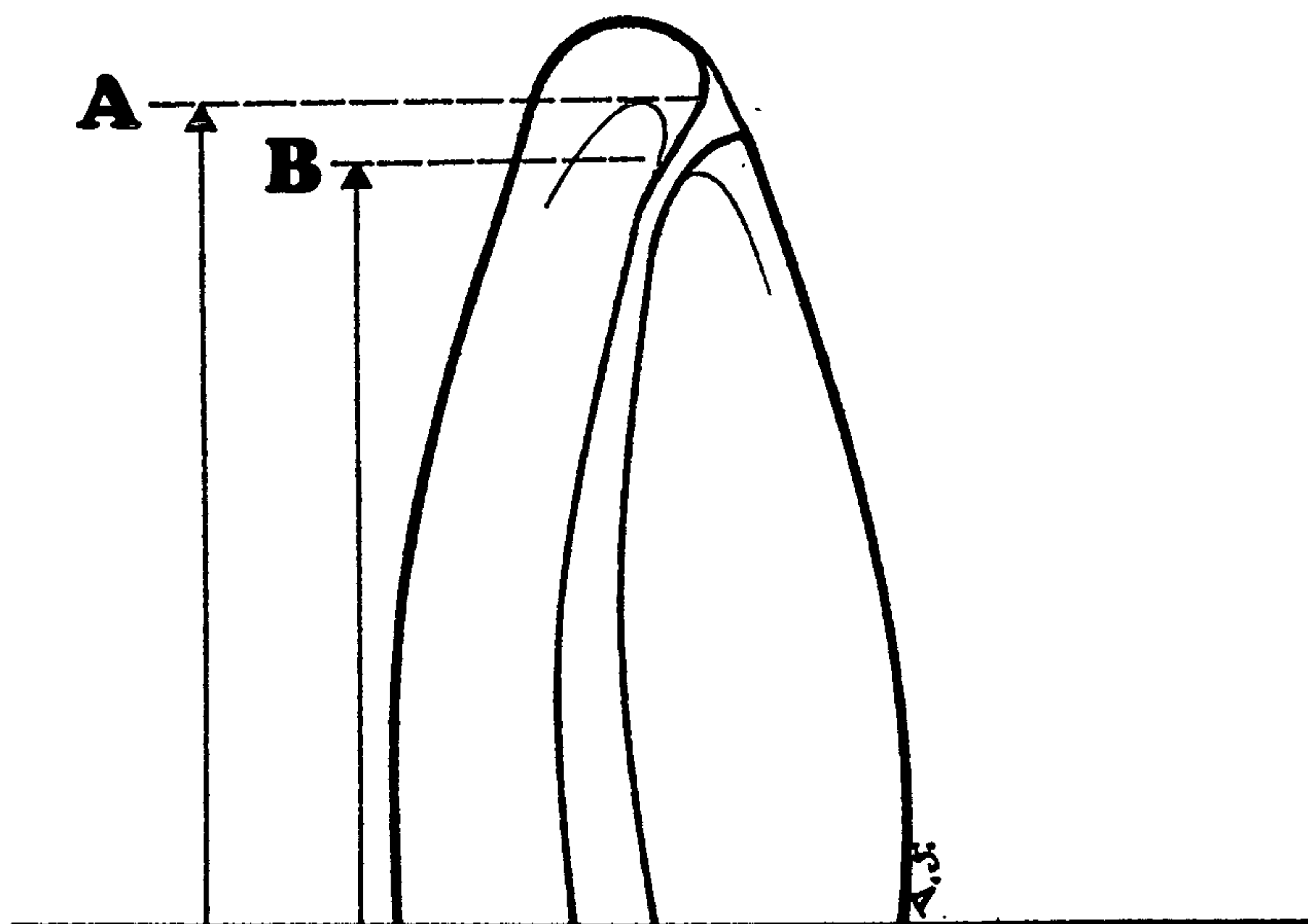


FIGURE 1.2

The cemento-dentinal junction as described by Kuttler (1955) where the distance between the inner (B) and outer diameter (A) of the junction is between 0.5-0.8 millimetre (from Sebbag 1984).

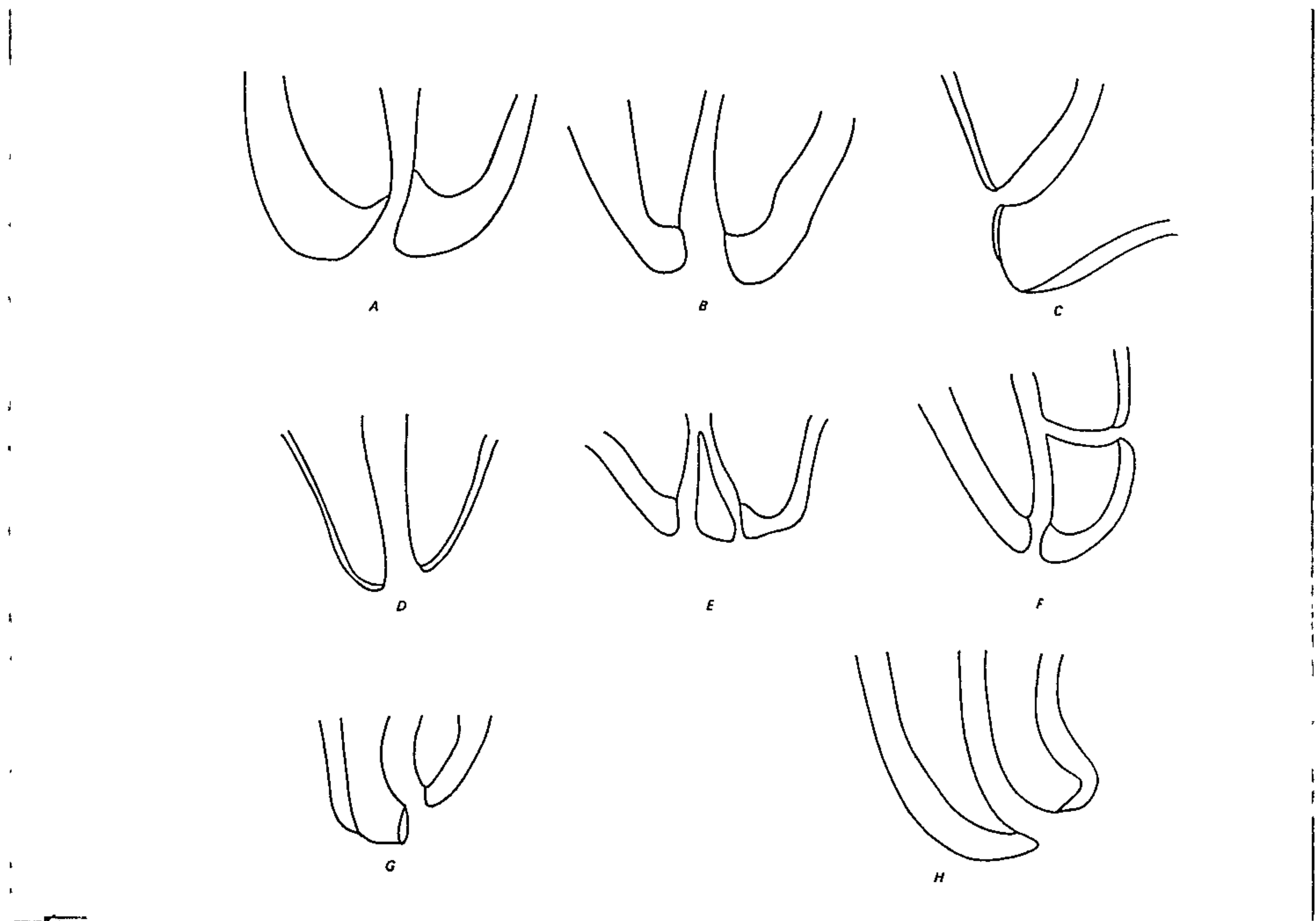


FIGURE 1.3

Variable anatomy of the cemento-dentinal junction. (A) classical foramen, (B) open foramen, (C) deviated foramen, (D) cementinal resorption, (E) apical delta, (F) apical lateral canal, (G) partial cemental resorption, (H) alteration of the cemental portions of the junction (from Ricci et al 1986).

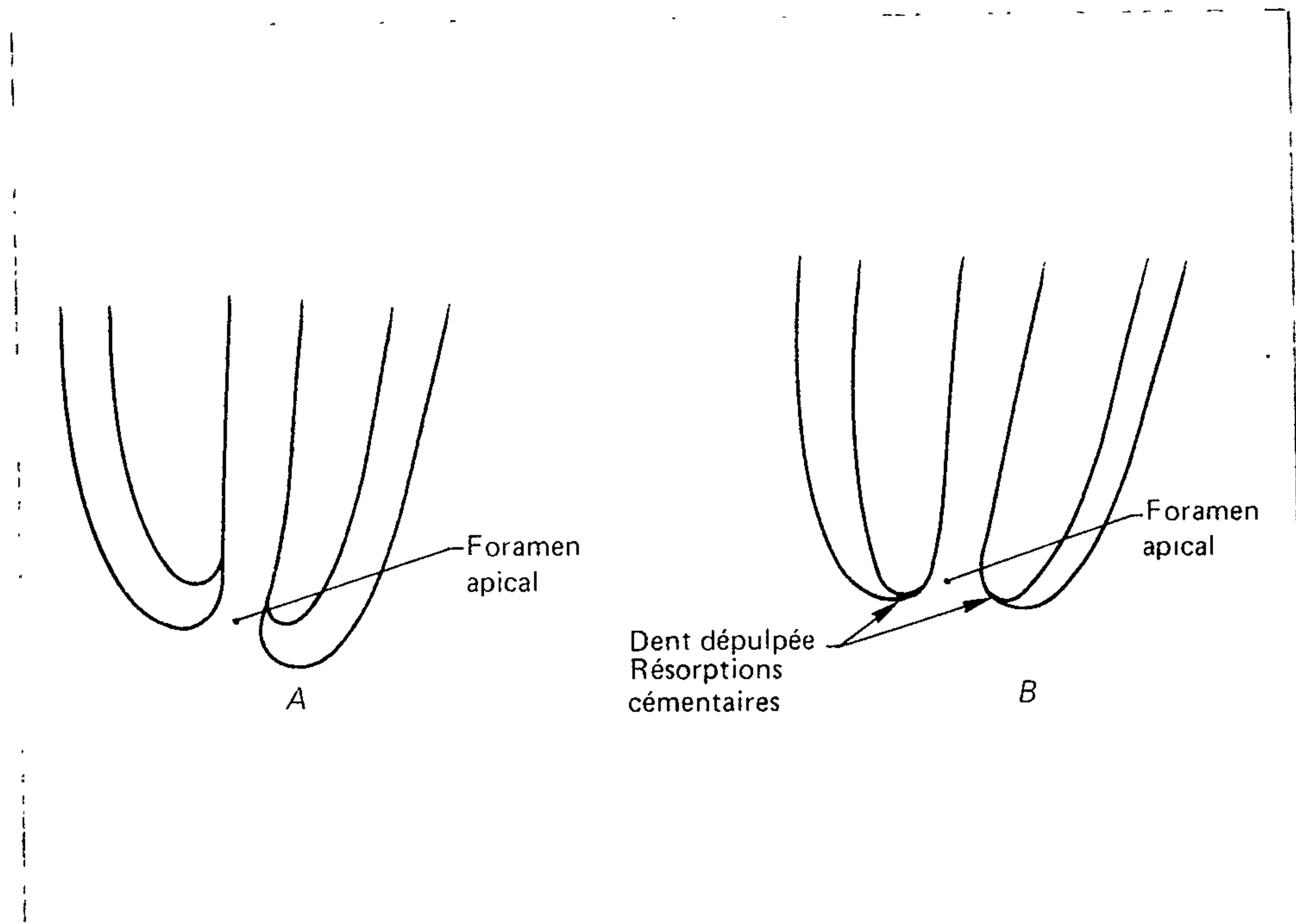


FIGURE 1.4

Differing apical architecture dependant on pulp status. (A) vital pulp with cemento-dentinal junction in position, (B) pulpless tooth with resultant cemental resorption (from Ricci et al 1986).

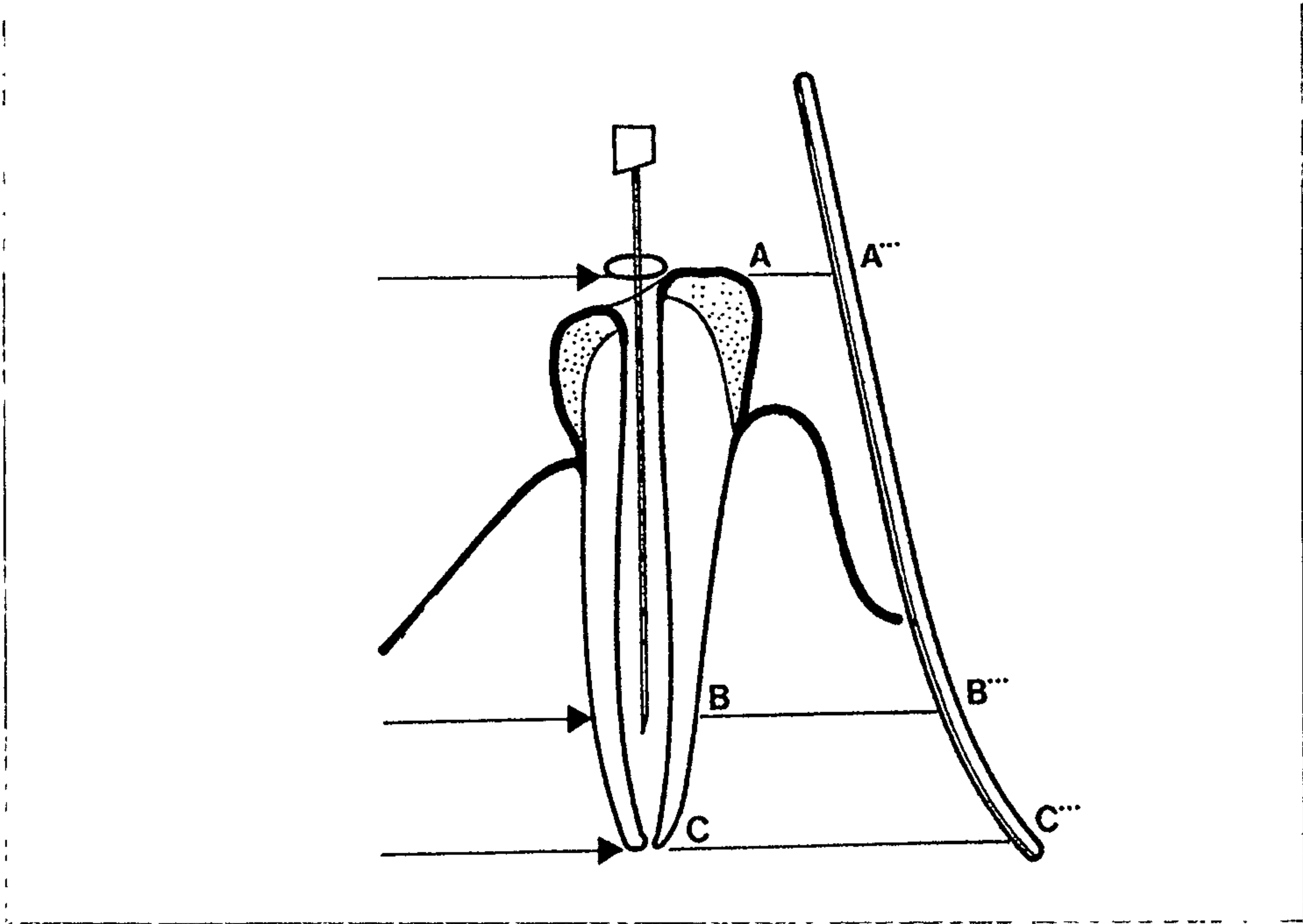


FIGURE 3.1

Radiographic length determination using the bisecting-angle technique often produces a bent film resulting in falsification of the proportional calculation and varying distortion along the length of the film. Distortions per unit area are greatest in the apical regions, ie: BC is greather than B''C'' (after O'Mullane 1969 from Sebbag 1984).

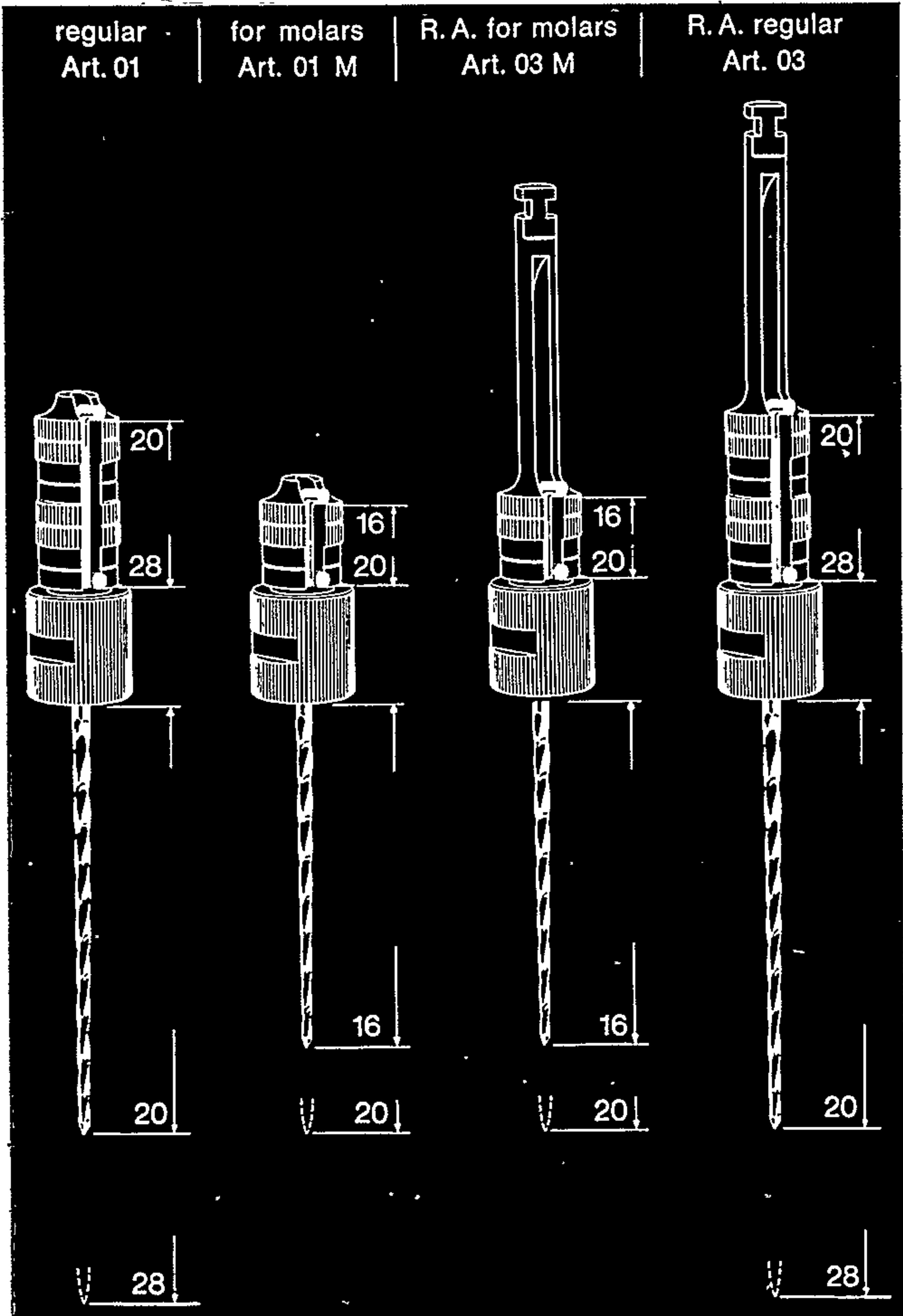


FIGURE 3.2

Mayer test handles for canal length determination. The variety of lengths available in test handles are shown.

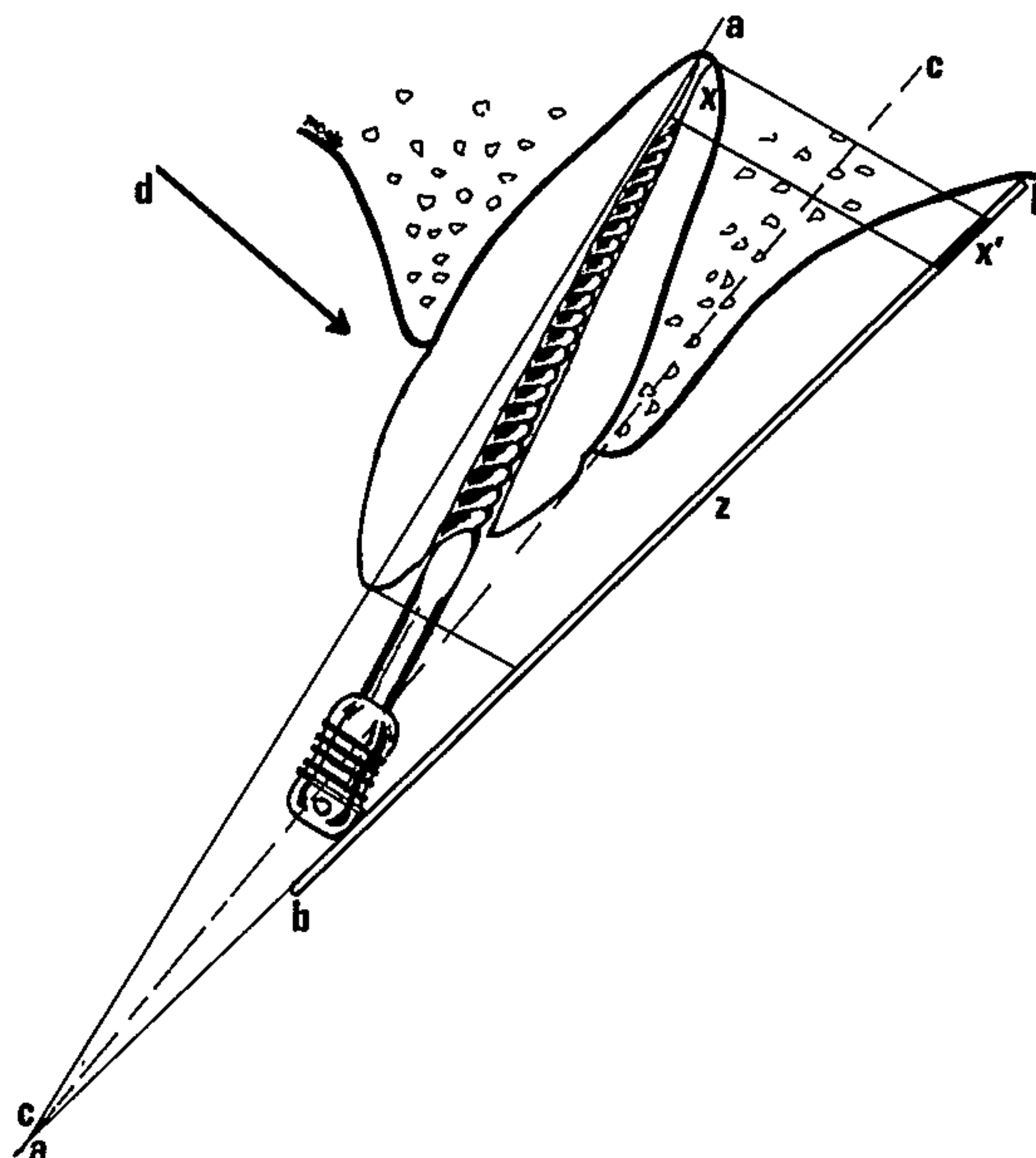


FIGURE 4.1

Working length determination using the mathematical ratio method and the bisecting angle radiographic method. a-a: long axis of tooth, b-b: film, c-c: line bisecting angle formed by a-a and b-b, d: central ray, x+z: radiographic length of tooth, x: distance between apical tip of instrument and radiographic apex, x': error introduced by instrument and tooth being in differing mesio-distal planes (modified from Blayney 1928 and Holmes 1969).

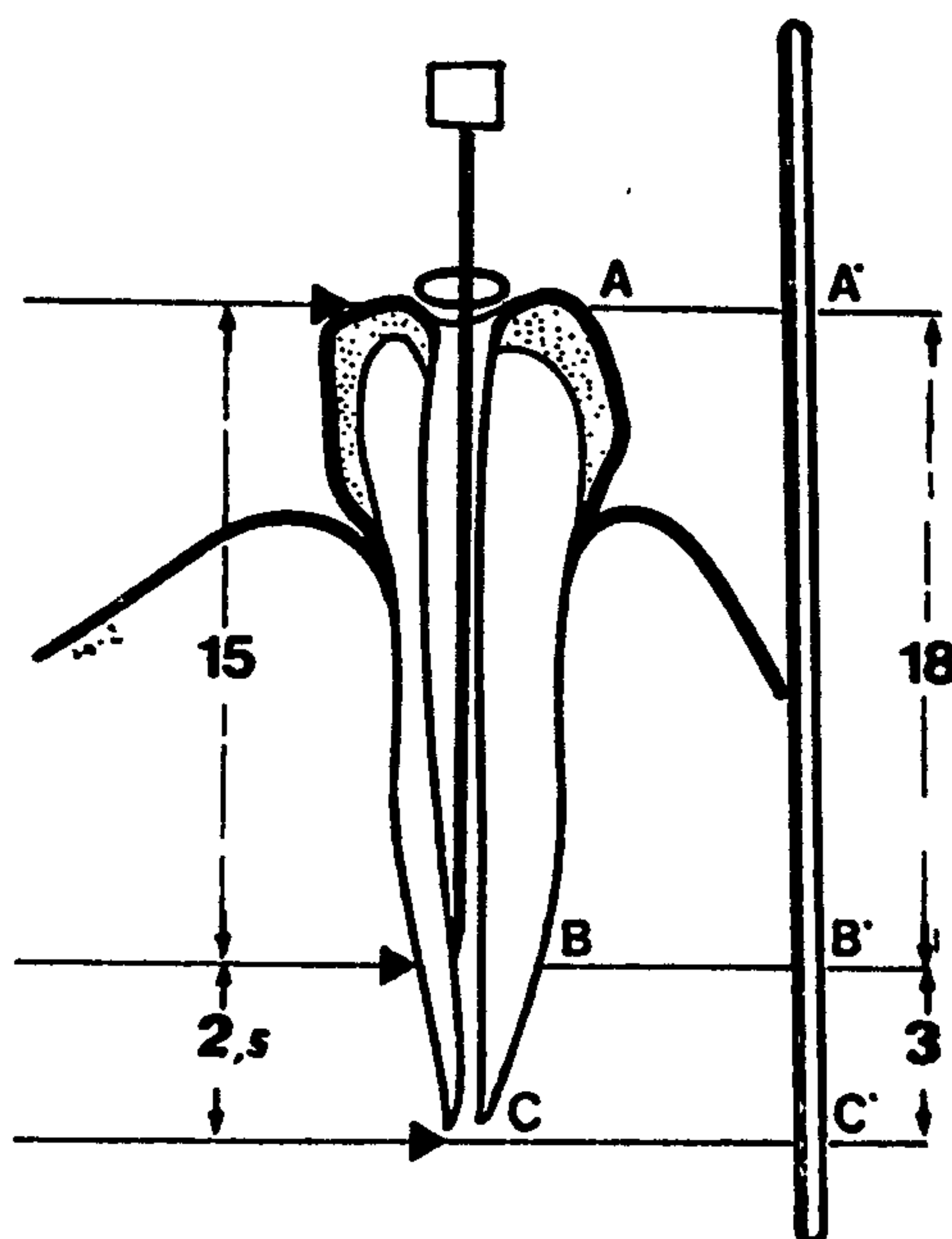


FIGURE 4.2

Proportional modified formula method of endodontic working length determination. Proportionality is present between the object (tooth/instrument) and the radiographic image

$$\text{where } \frac{A B}{A' B'} = \frac{B C}{B' C'}$$

(modified from Holmes 1969, from Sebbag 1984).

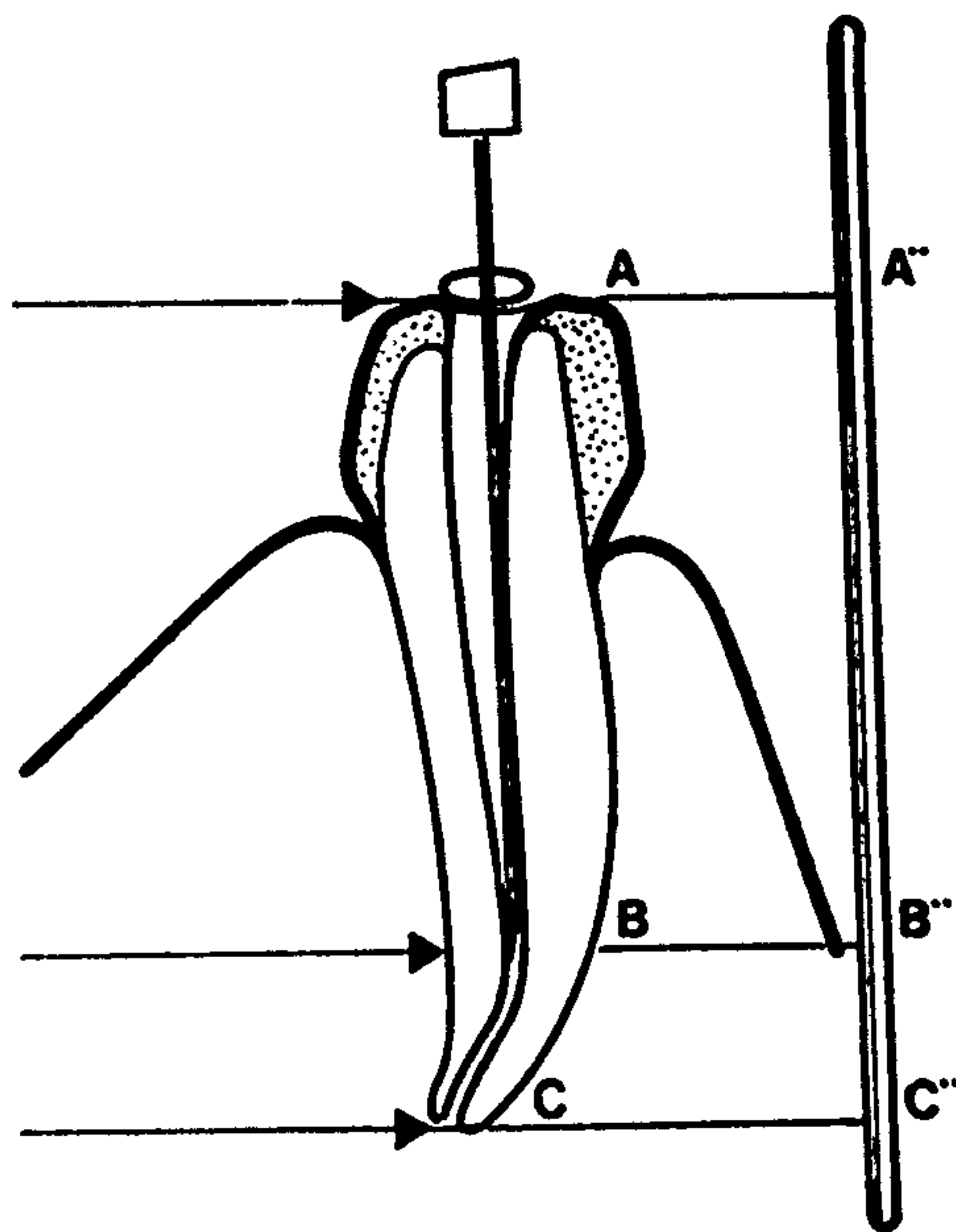


FIGURE 4.3

Root curvature will render the proportional method of working length determination inaccurate as $BC = B''C''$ (from Sebbag 1984).

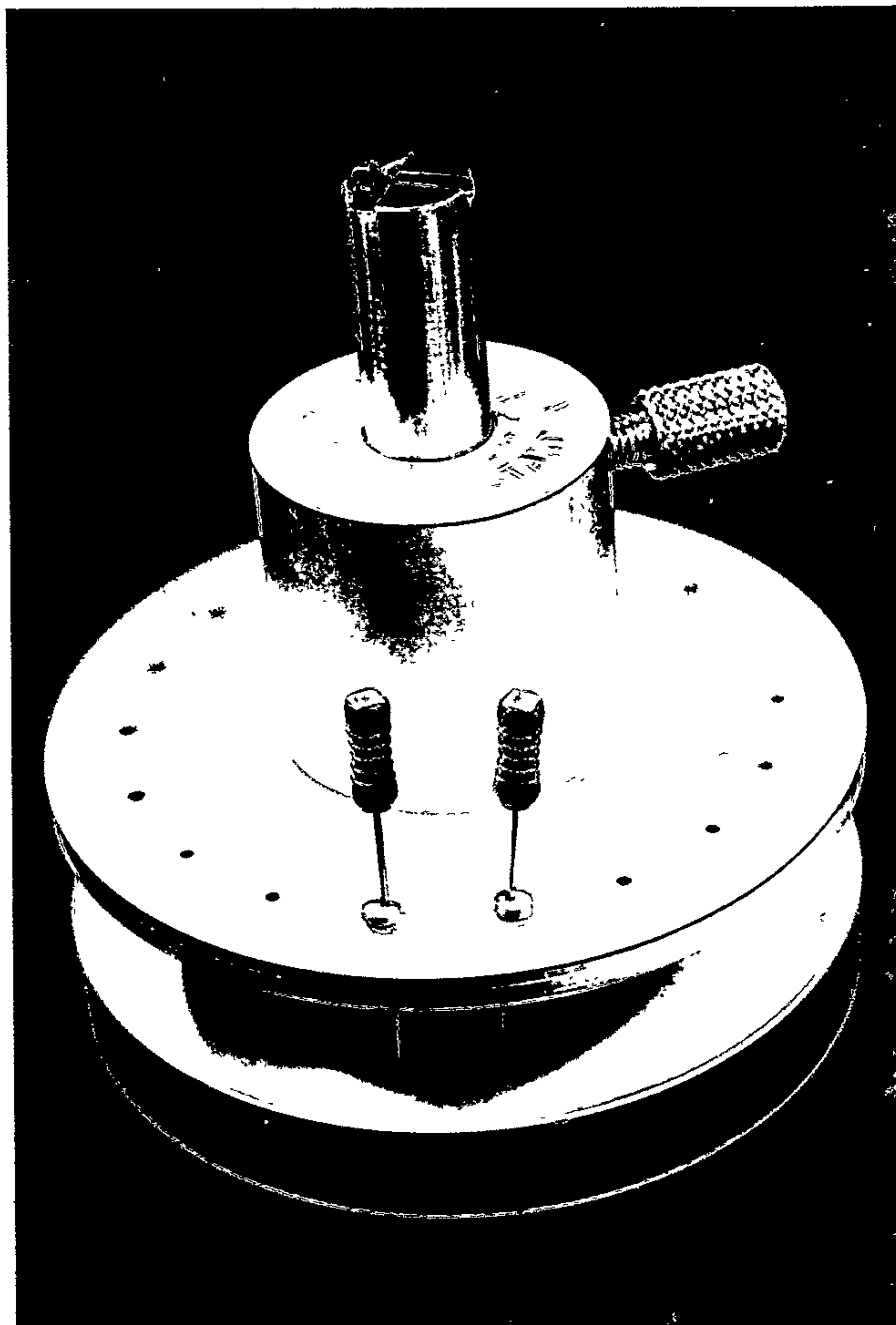


FIGURE 4.4

The "K.D." Endo-gauge.

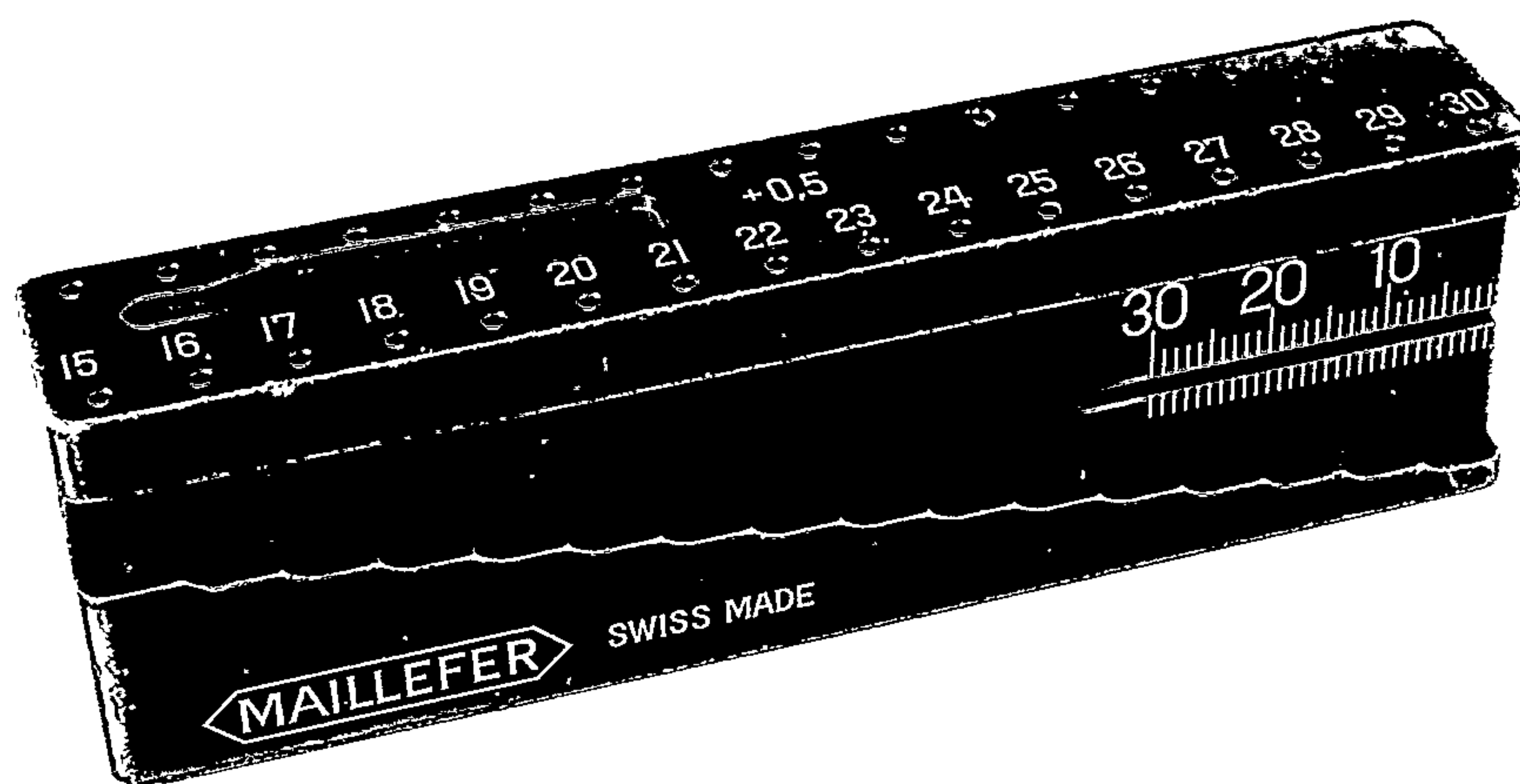


FIGURE 4.5

The Maillefer "Endo-block".

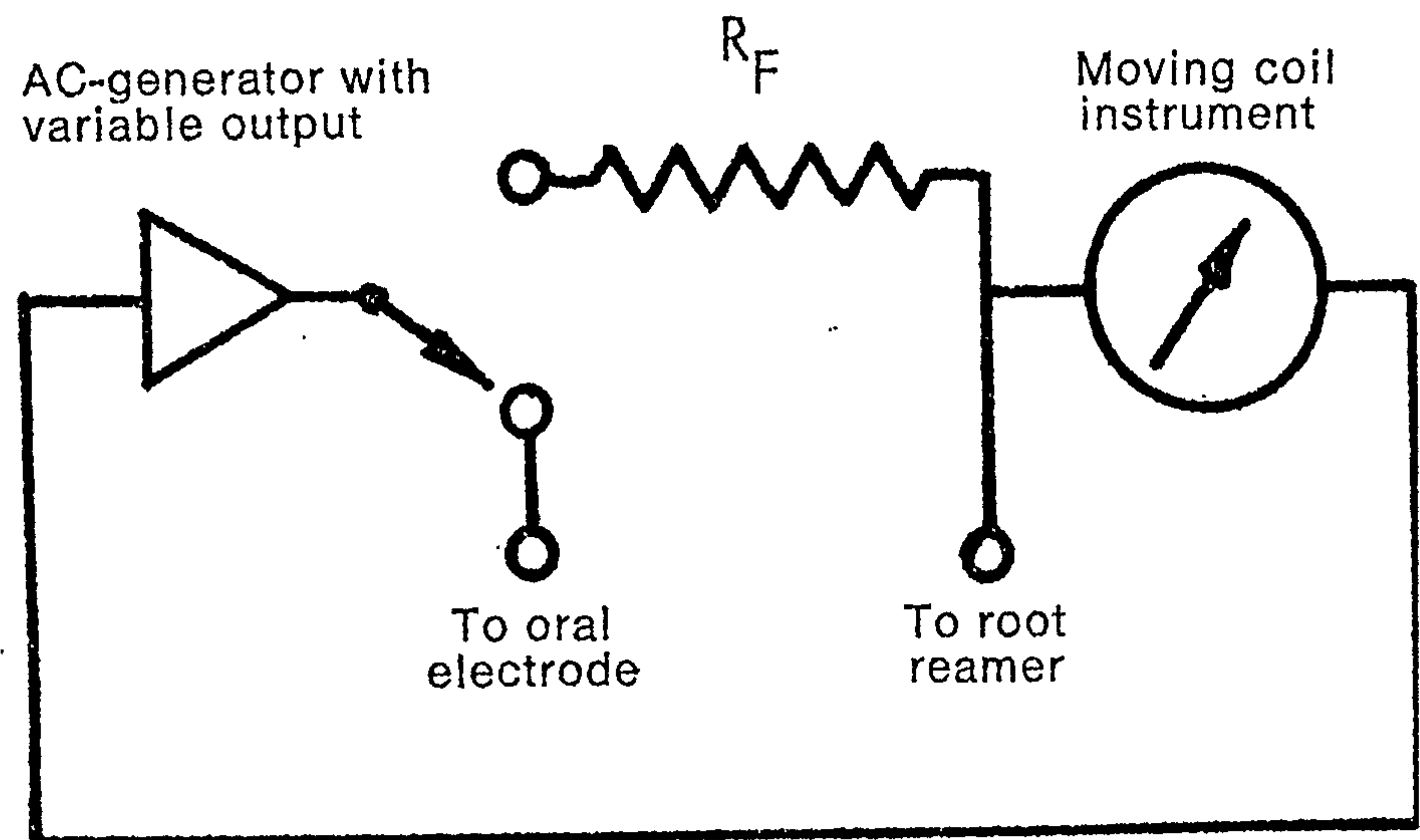


FIGURE 5.1

Block diagram: analogue type of electronic root canal measuring device (from Dahlin 1979).

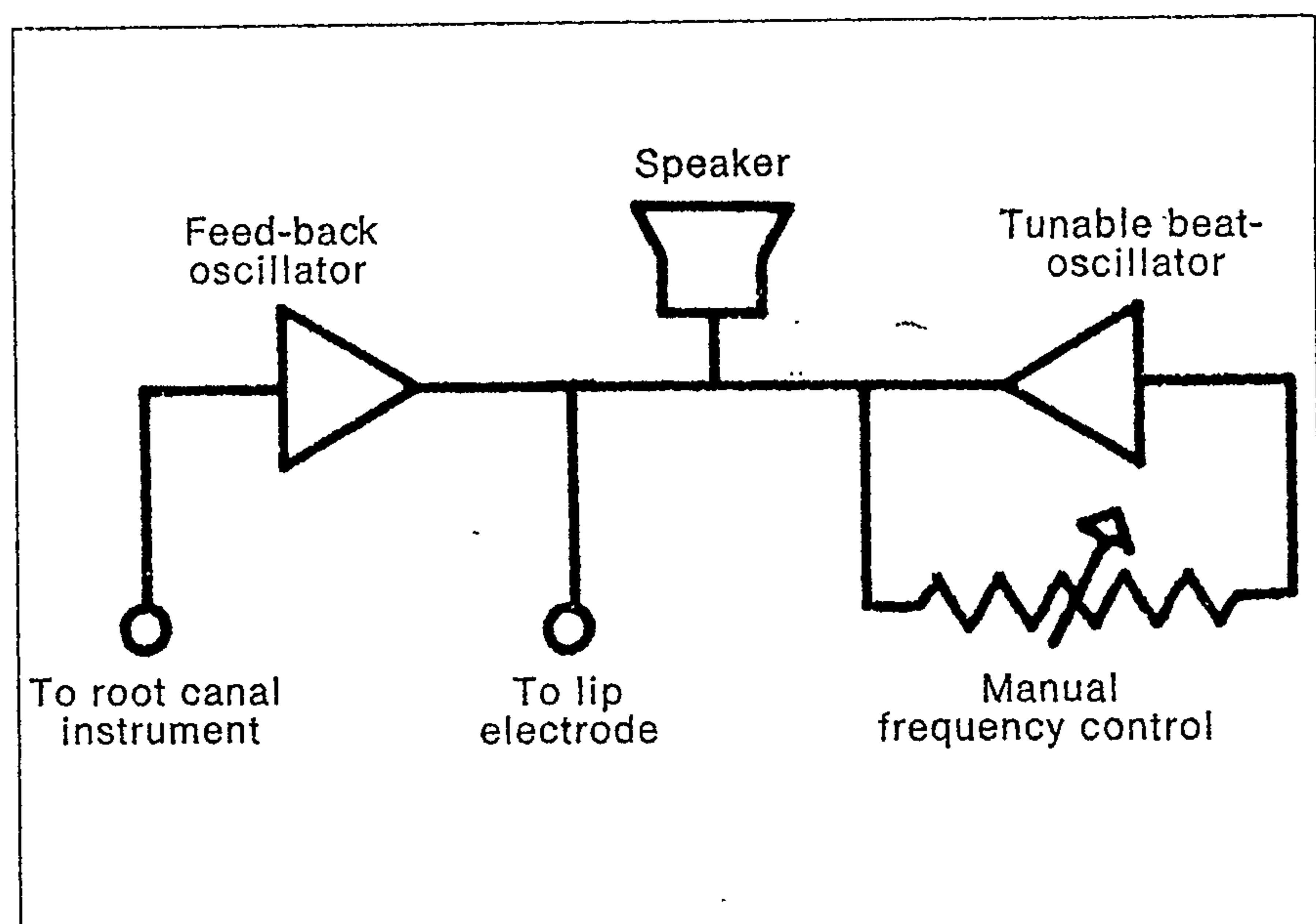


FIGURE 5.2

Block diagram: audio-indicating type of electronic root canal measuring device (from Dahlin 1979).

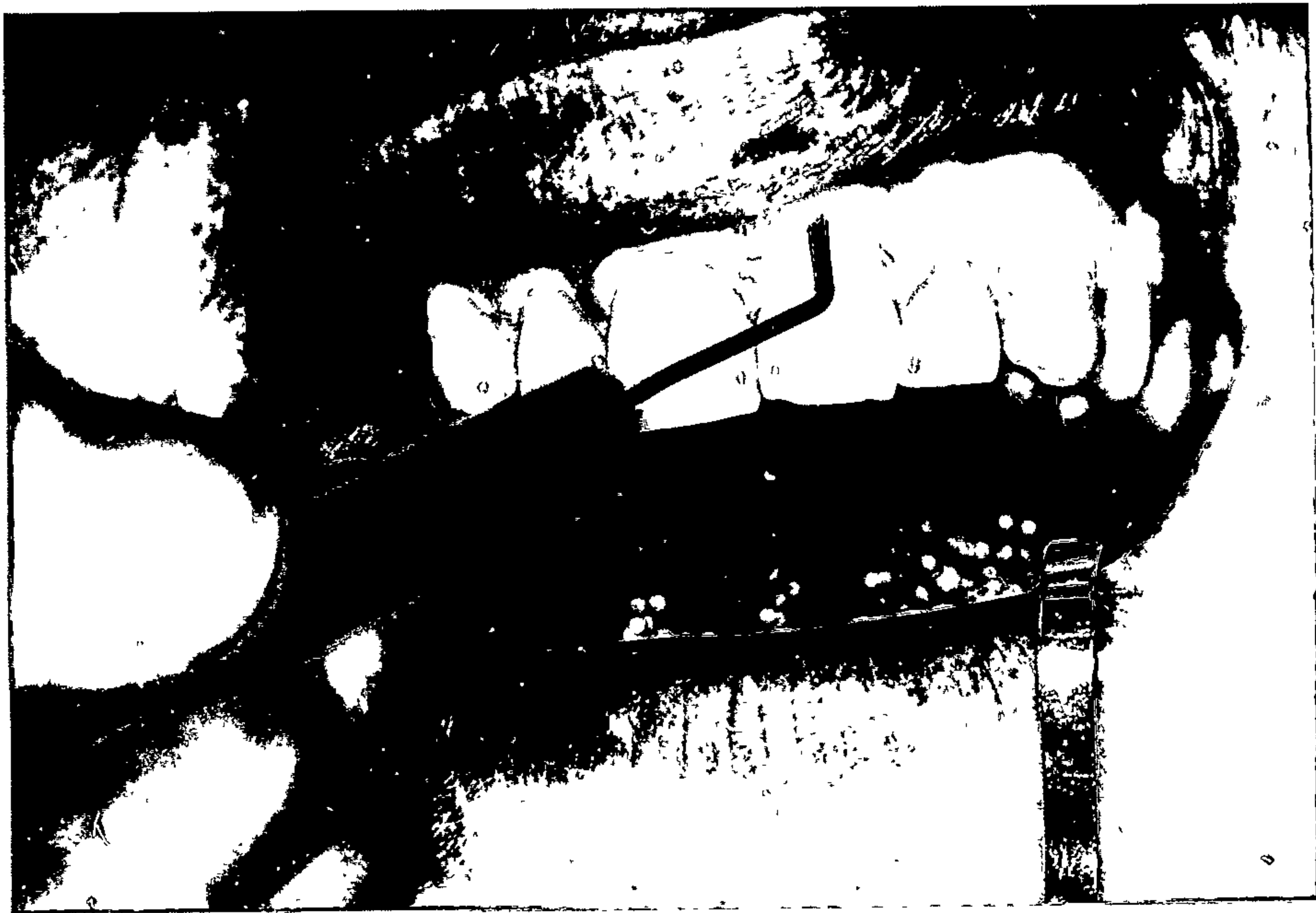


FIGURE 8.1

Use of the Endo-Radar sulcus probe. To calibrate the device the probe is placed 0.5 to 1.0 millimetre into a healthy gingival crevice.

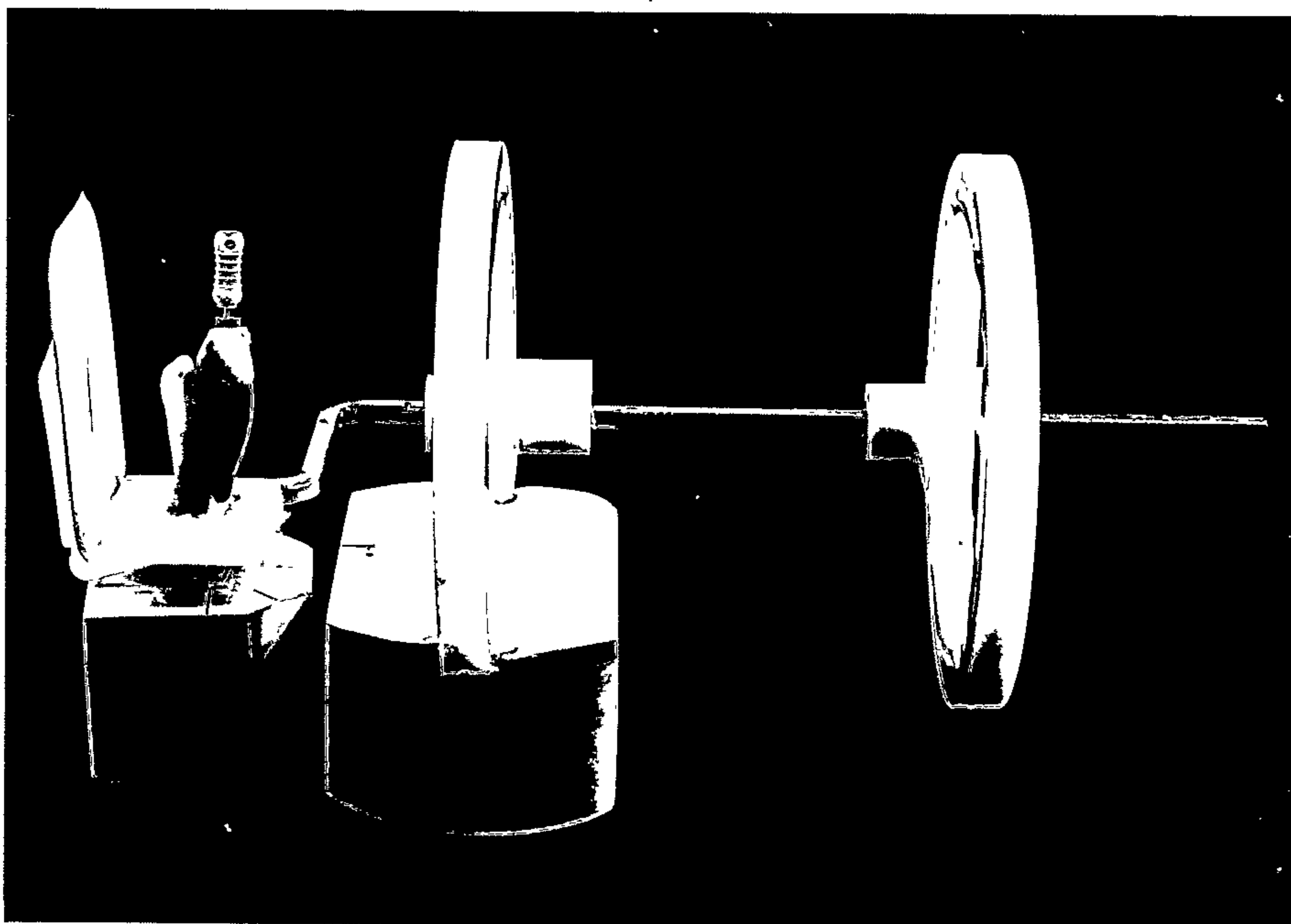


FIGURE 8.2

Radiographic jig used in the Anatomic Study (Investigation A) (modified from R.P. Thomas 1986).

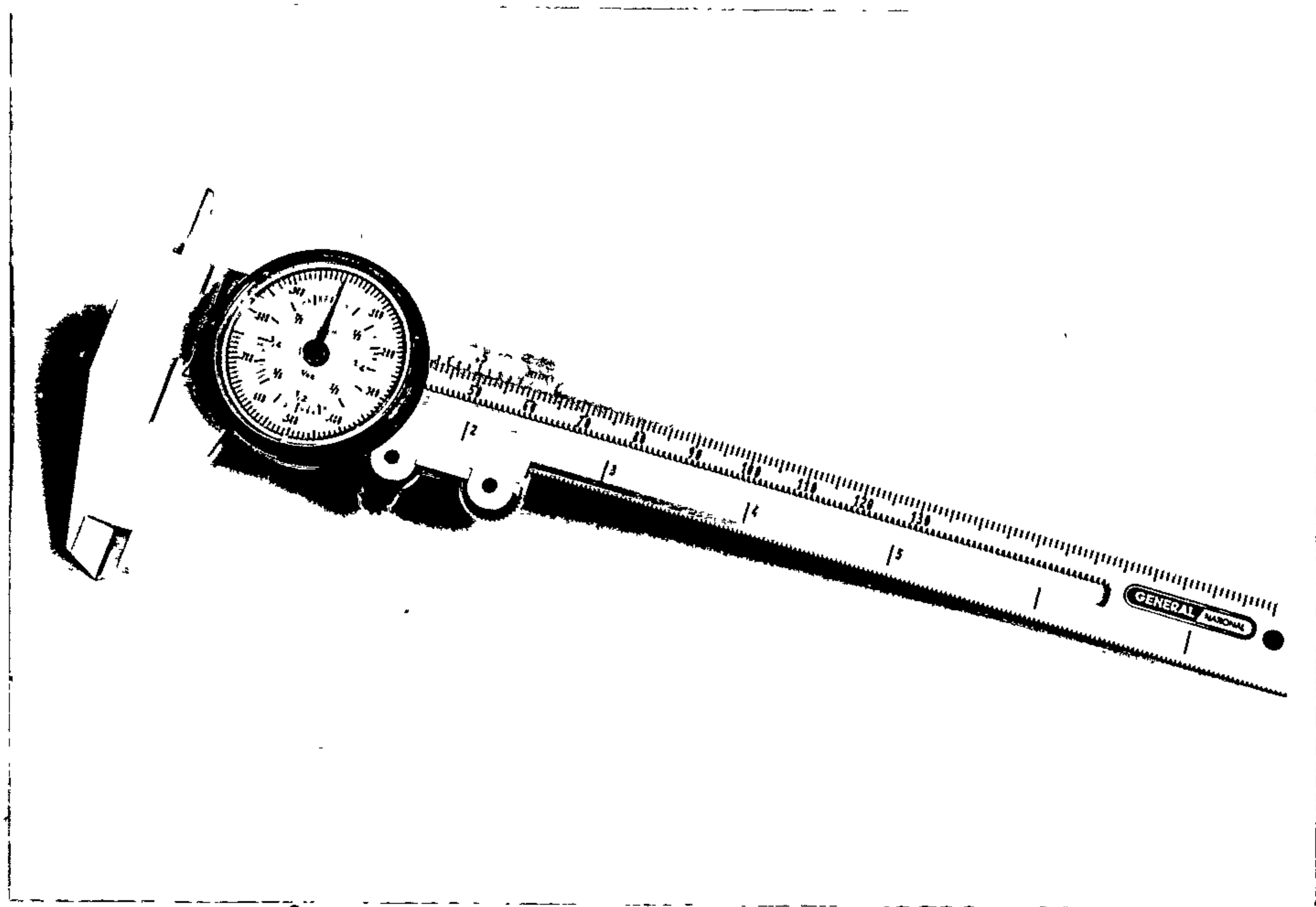


FIGURE 8.3

Engineer's dial caliper used to measure file length in the Anatomic Study (Investigation A).

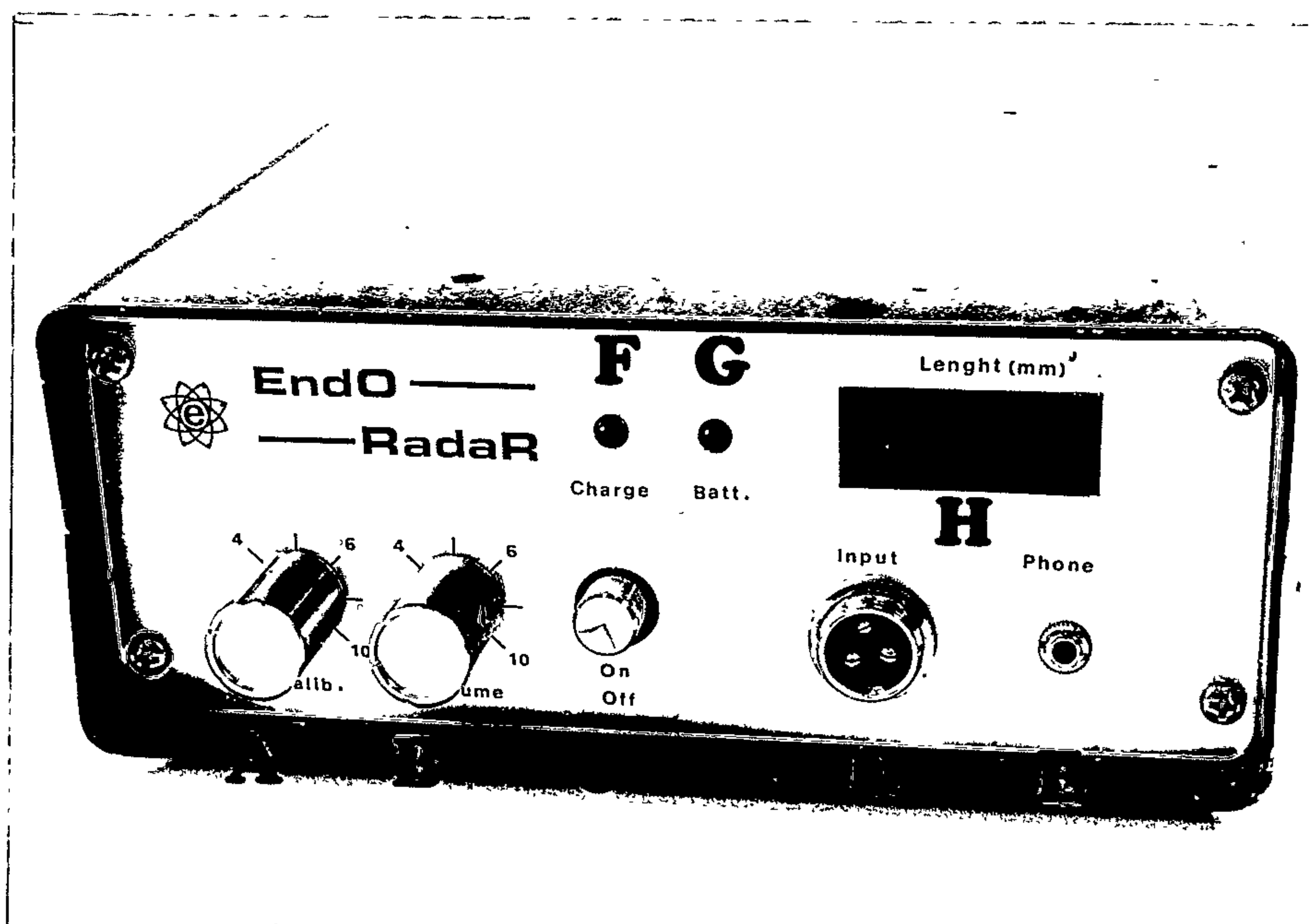


FIGURE 8.4

The Endo-Radar. (A) calibration control, (B) volume control, (C) on/off switch, (D) input jack, (E) earphone connector, (F) "charge" indicator light, (G) low battery charge warning light, (H) digital display screen.

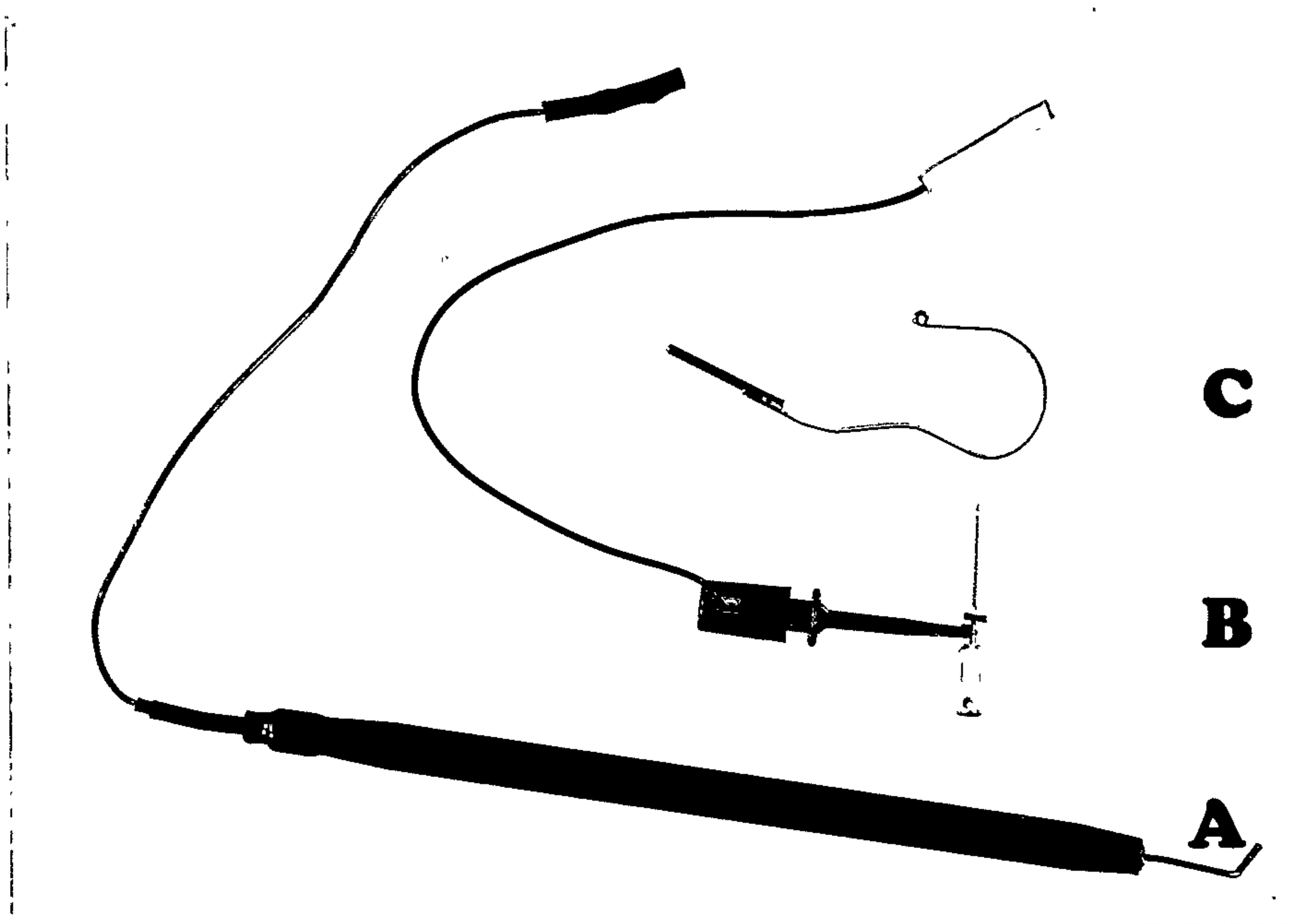


FIGURE 8.5

Endo-Radar equipment. (A) sulcus probe, (B) alligator clip for endodontic instrument, (C) lip connector.

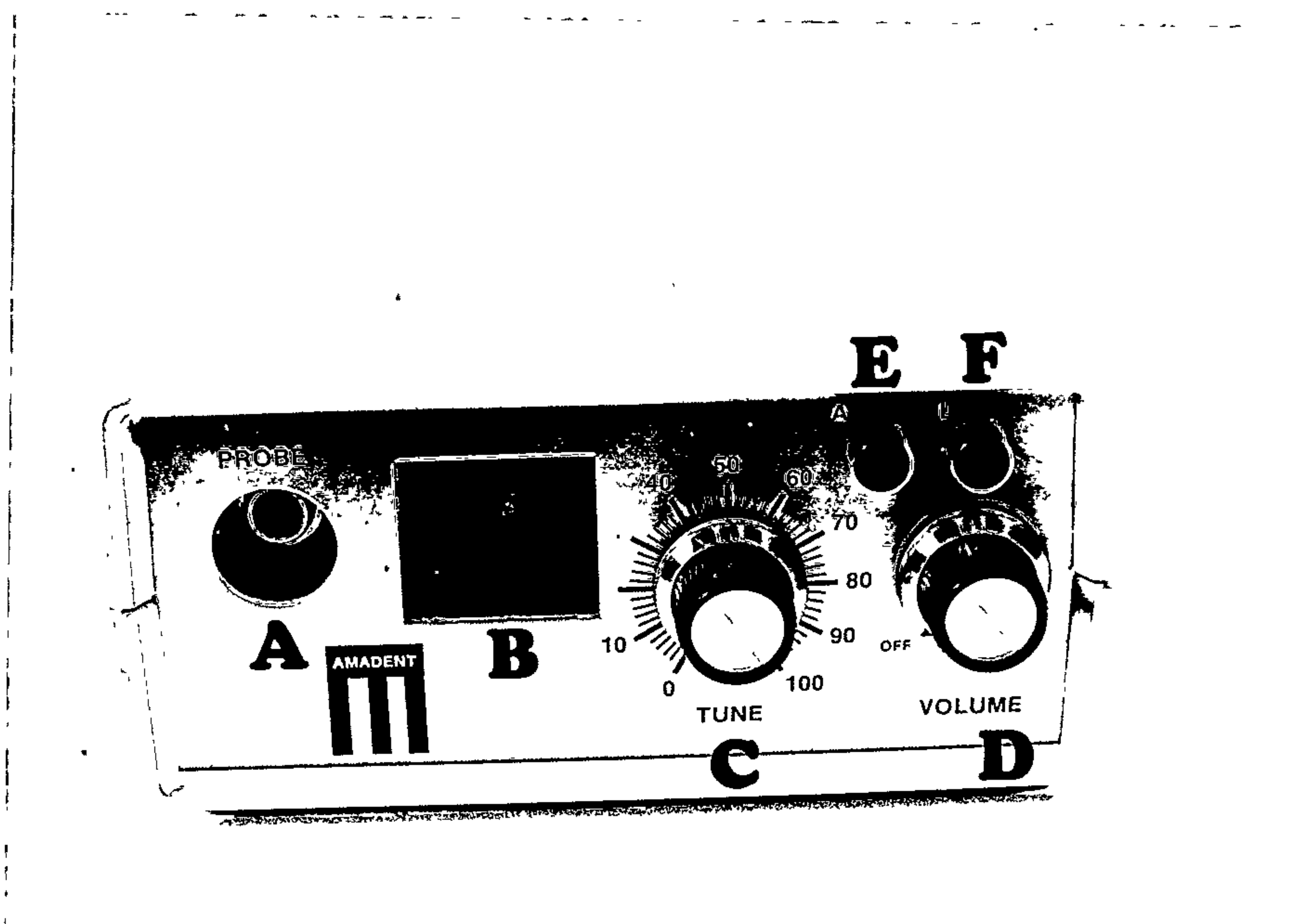


FIGURE 8.6

The Neo-Sono-D. (A) probe connection socket, (B) digital display screen, (C) tuner, (D) volume control, (E) light emitting diode indicating "apex" reached, (F) light emitting diode indicating instrument beyond the "apex".

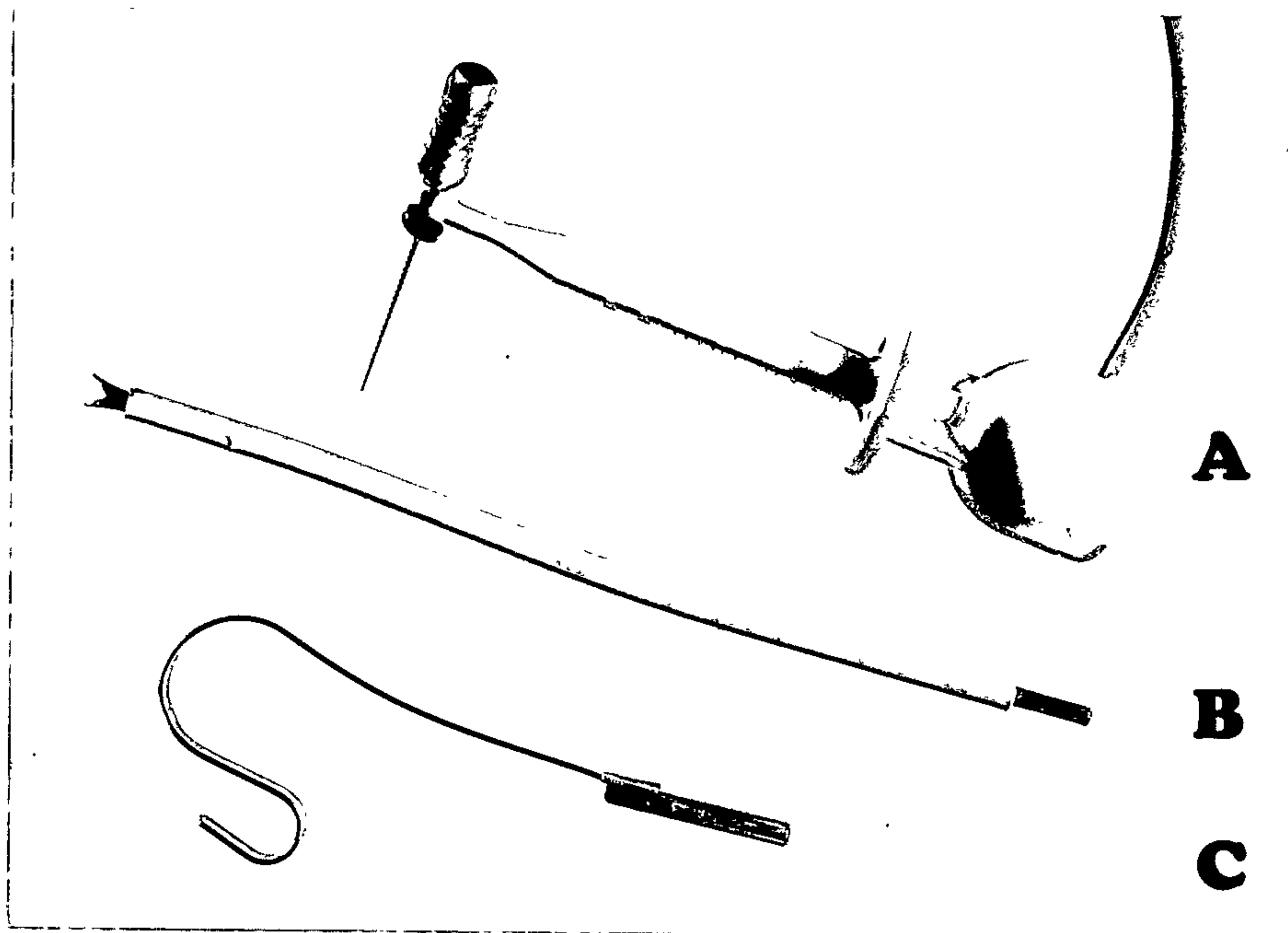


FIGURE 8.7

The Neo-Sono-D. (A) alligator clip for endodontic instrument, (B) straight probe - may be used in place of alligator clip (A), (C) lip connector.



FIGURE 8.8

The Endo-Radar as used in the Clinical study (Investigation B).

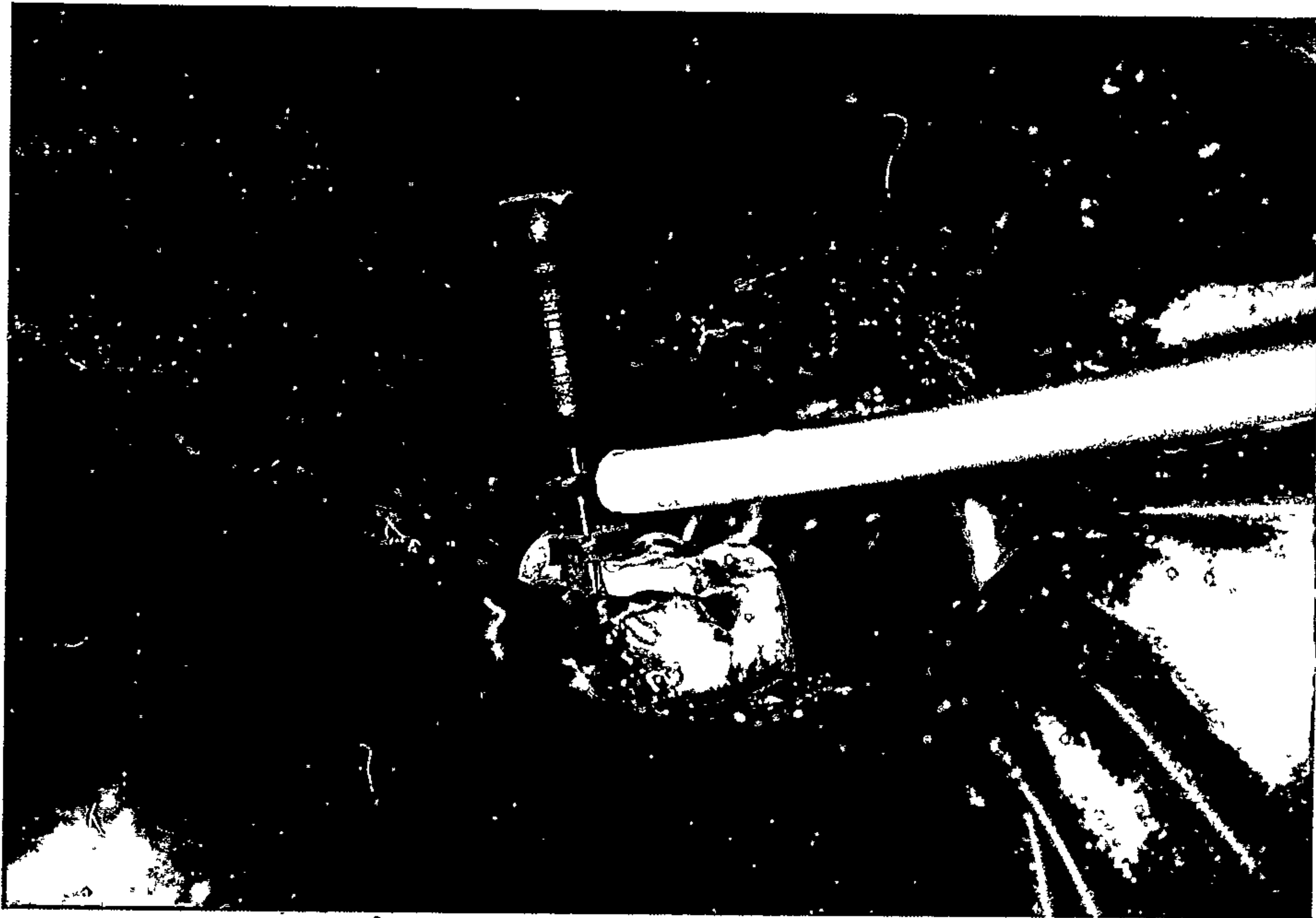


FIGURE 8.9

The Neo-Sono-D as used during the Clinical study (Investigation B).

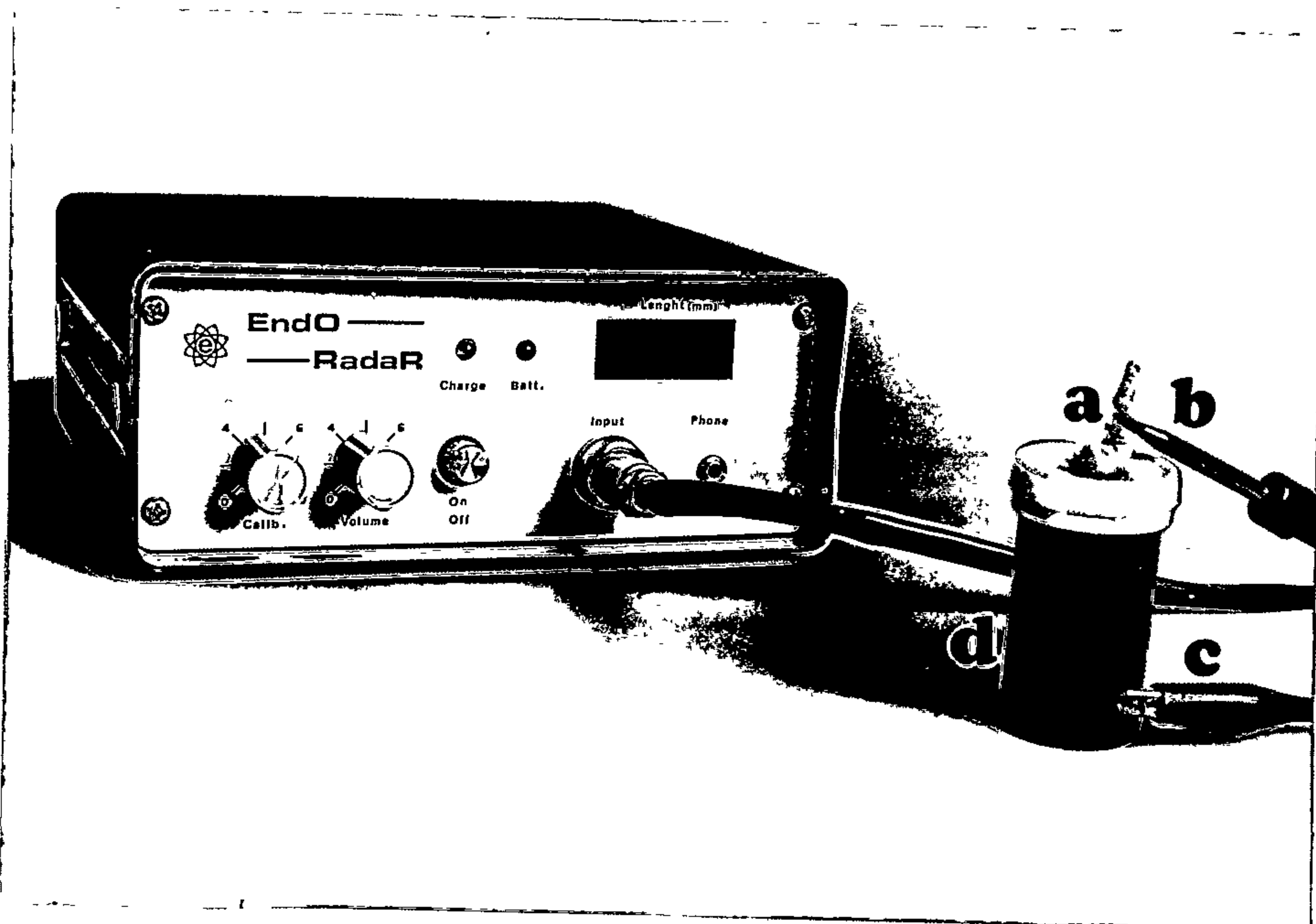


FIGURE 8.10

The Endo-Radar as used to record length measurements during the Laboratory Study (Investigation C). (A) tooth with instrument in place, (B) alligator clip, (C) second alligator clip duplicating the mucous membrane electrode, (D) plastic jar containing physiologic agar solution.

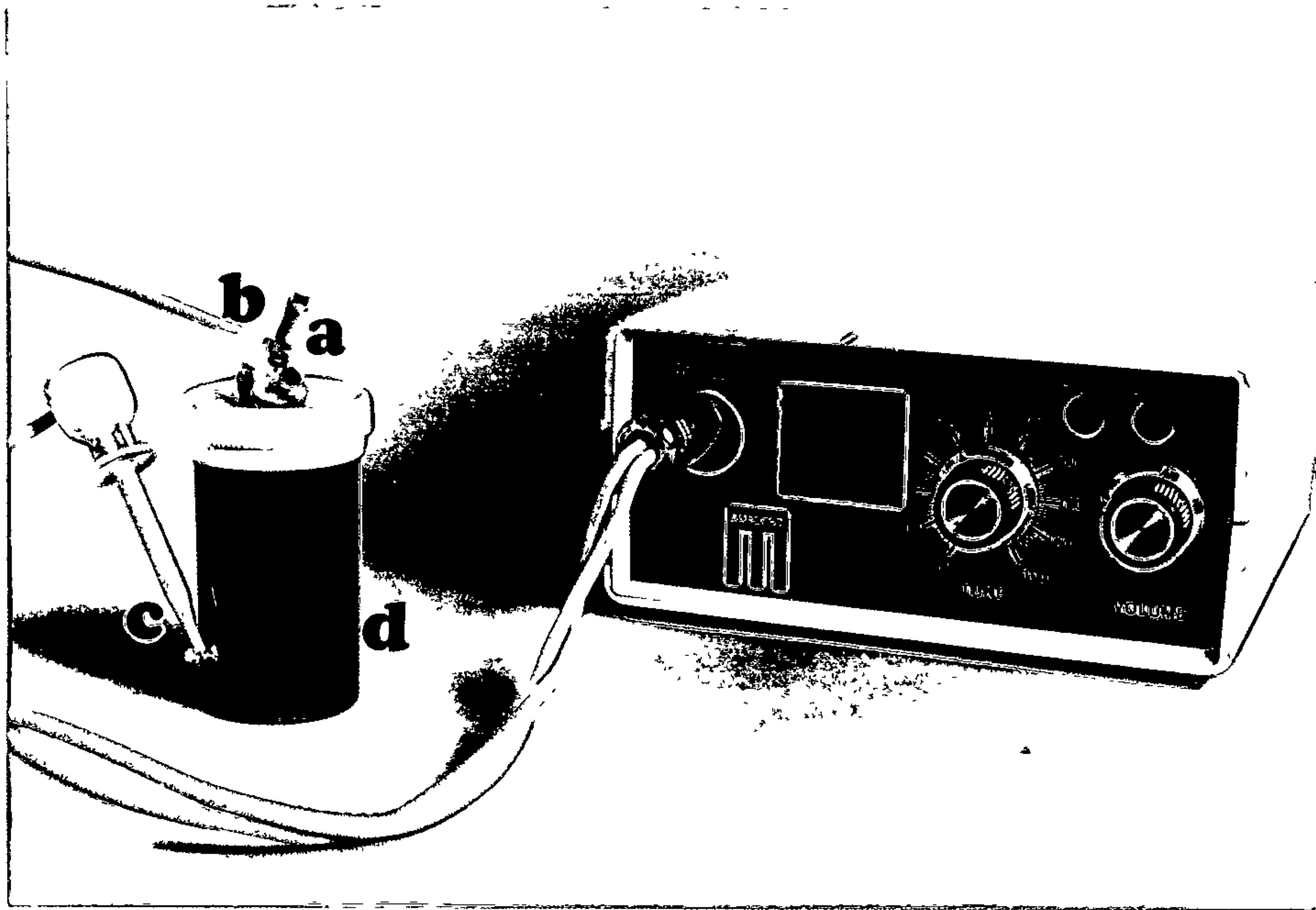


FIGURE 8.11

The Neo-Sono-D as used to record length measurements during the Laboratory Study (Investigation C). (A) tooth with instrument in place, (B) straight probe, (C) alligator clip acting as mucous membrane electrode, (D) plastic jar containing physiologic agar solution.

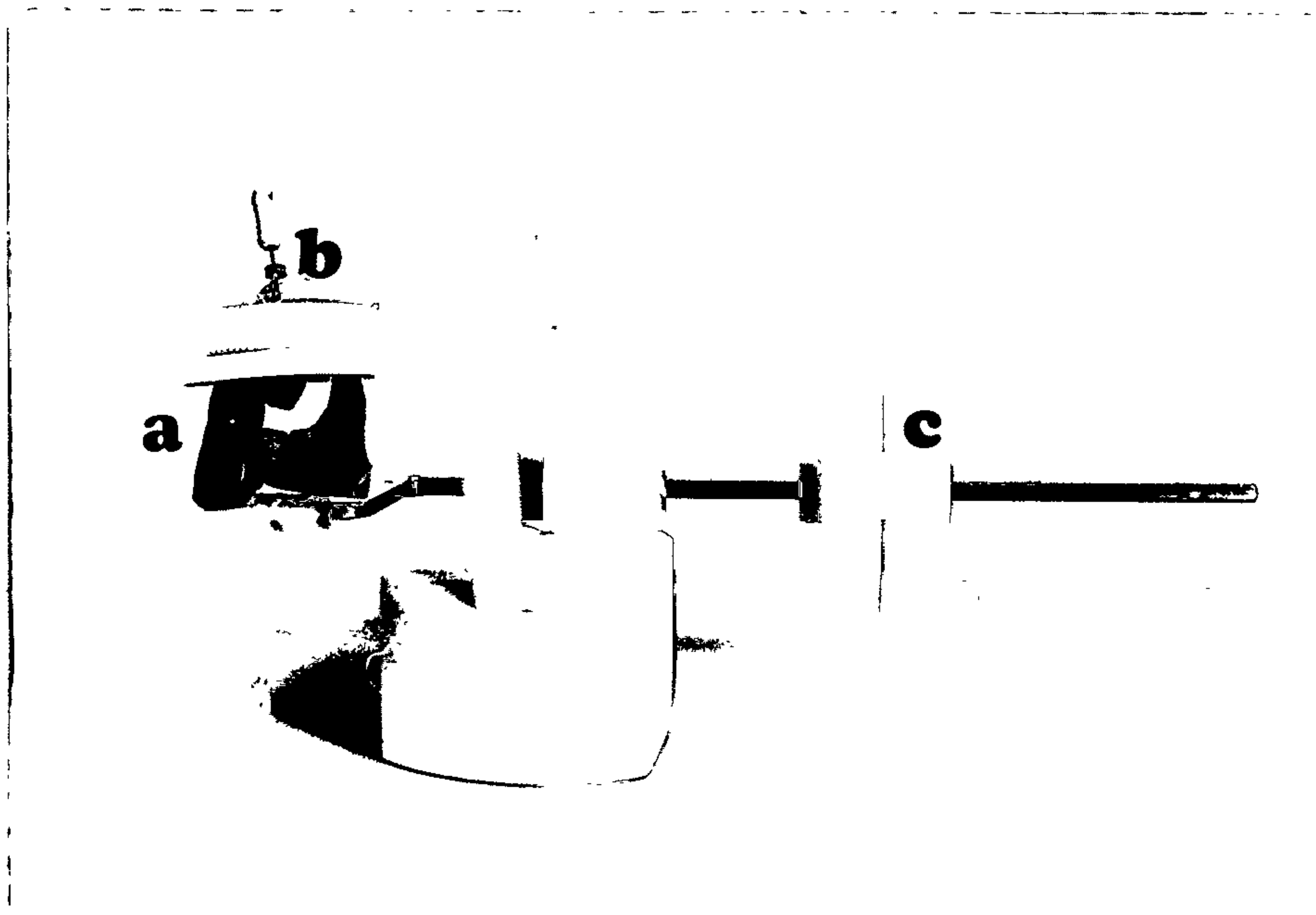


FIGURE 8.12

Beam aligning device used in the Laboratory Study (Investigation C). The tooth and plastic cap were placed in this device after electronic canal length determinations had been completed. (A) radiograph placed in this position, (B) tooth/instrument complex, (C) position of X-ray machine head.

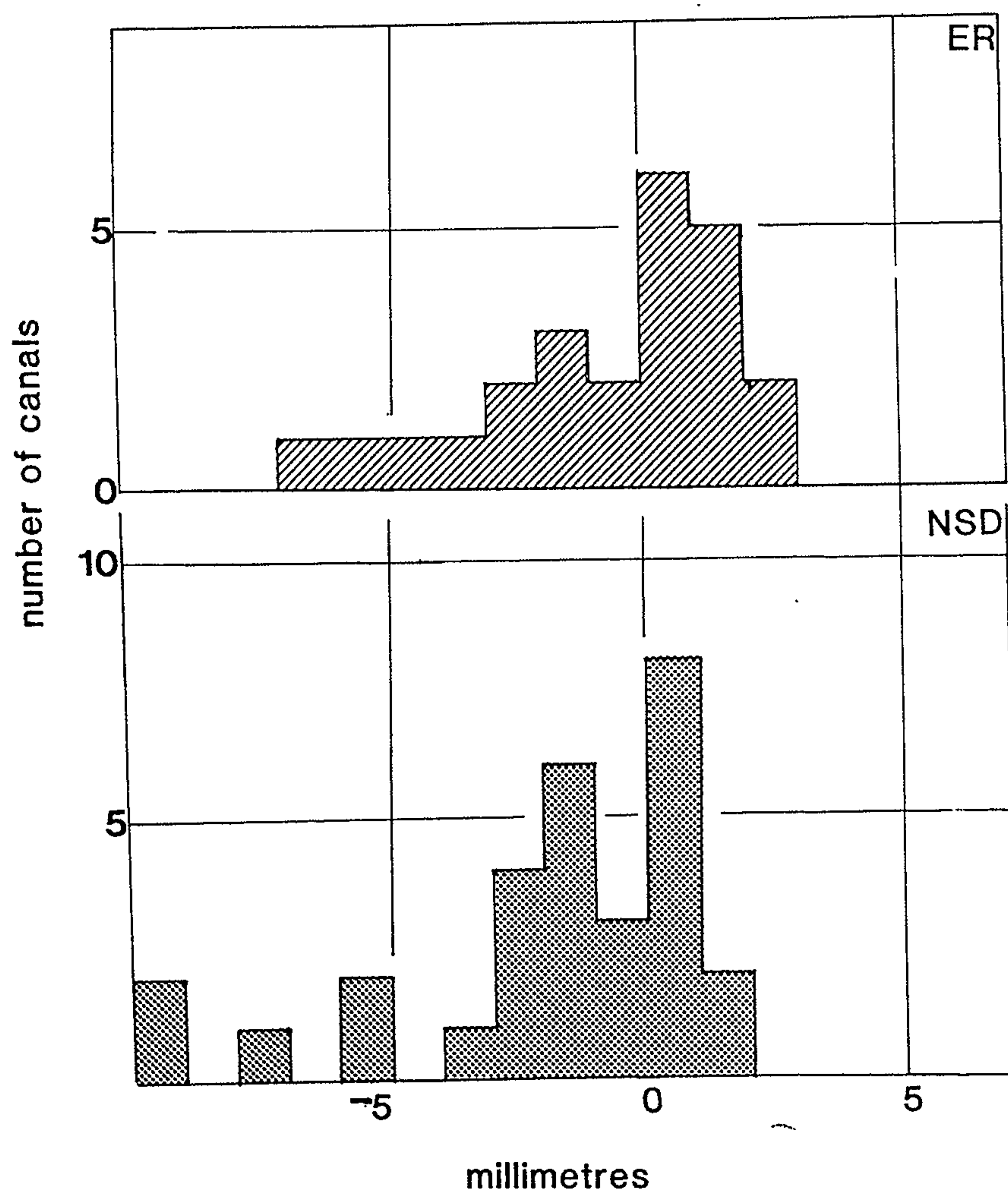


FIGURE 9.1

Investigation A (Anatomic Study). Pulp assessed as vital: Difference between indicated and measured canal lengths - Endo-Radar (upper) and Neo-Sono-D (lower). Standard deviation Endo-Radar: ± 2.34 , Neo-Sono-D: ± 2.84 .

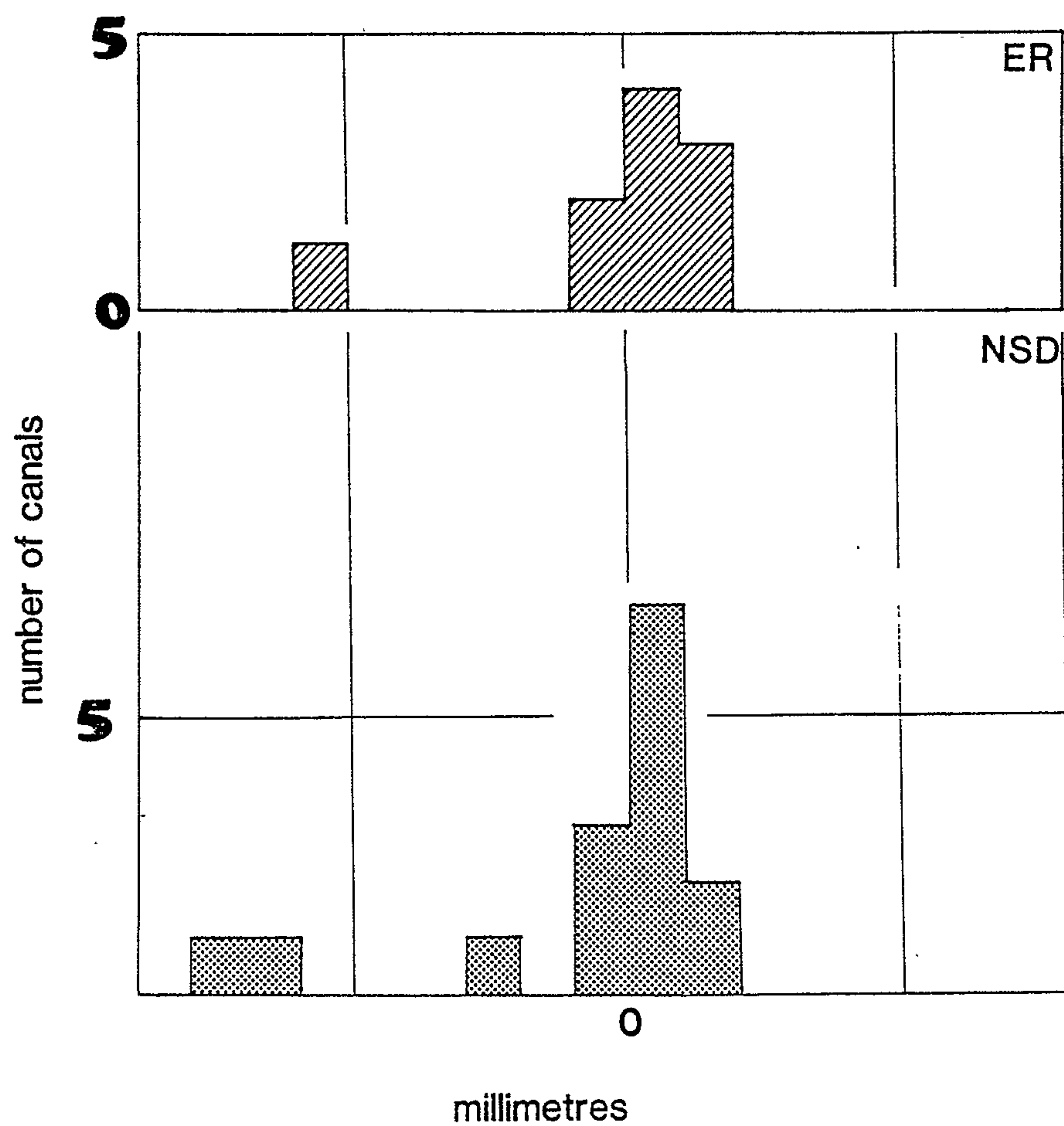


FIGURE 9.2

Investigation A (Anatomic Study). Pulps assessed as non-vital: Difference between indicated and measured canal lengths - Endo-Radar (upper) and Neo-Sono-D (lower). Standard deviation Endo-Radar: ± 2.08 , Neo-Sono-D: ± 2.53 .

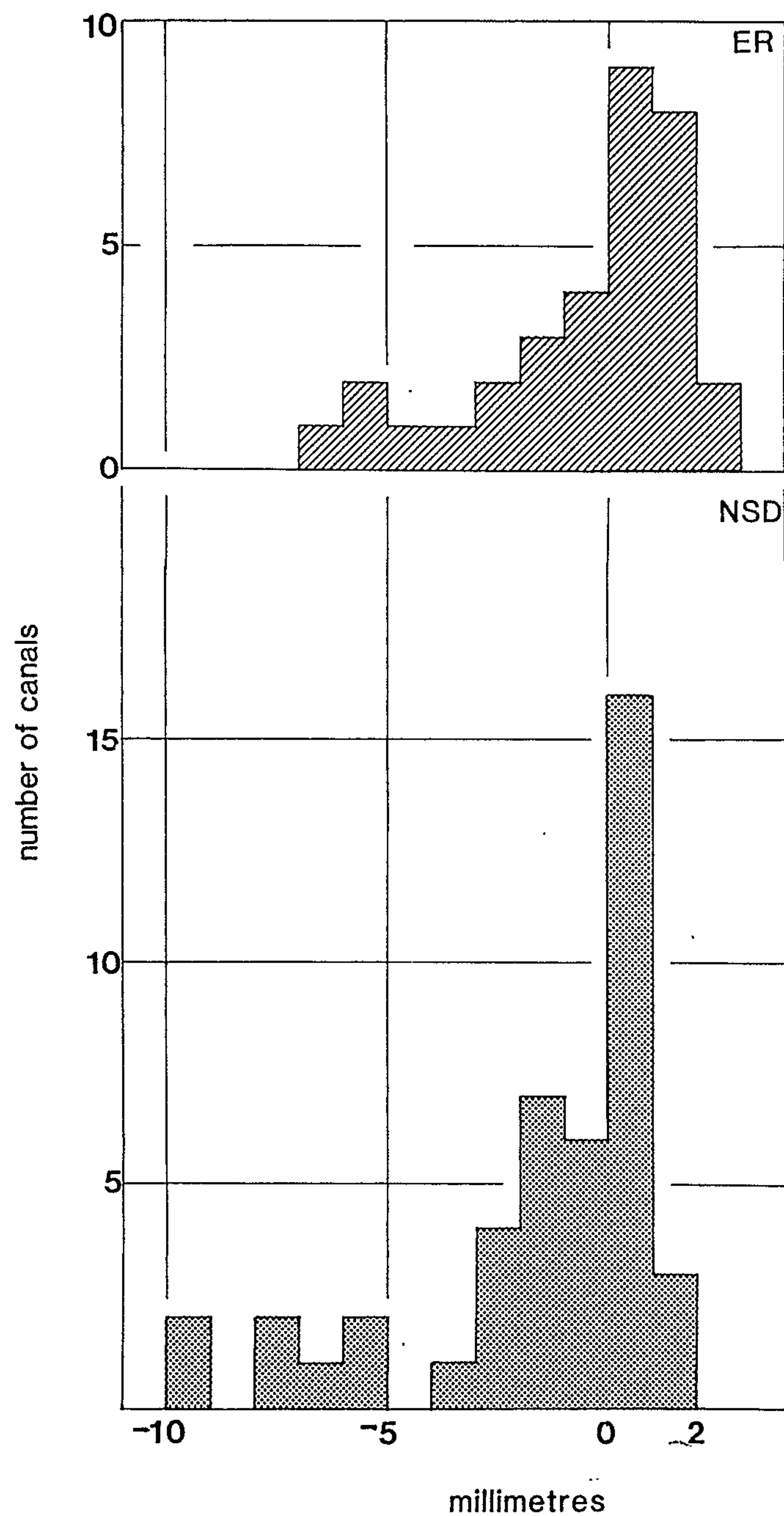


FIGURE 9.3

Investigation A (Anatomic study): Difference between indicated and measured canal lengths - Endo-Radar (upper) and Neo-Sono-D (lower). Standard deviation Endo-Radar: ± 2.28 , Neo-Sono-D: ± 2.79 .

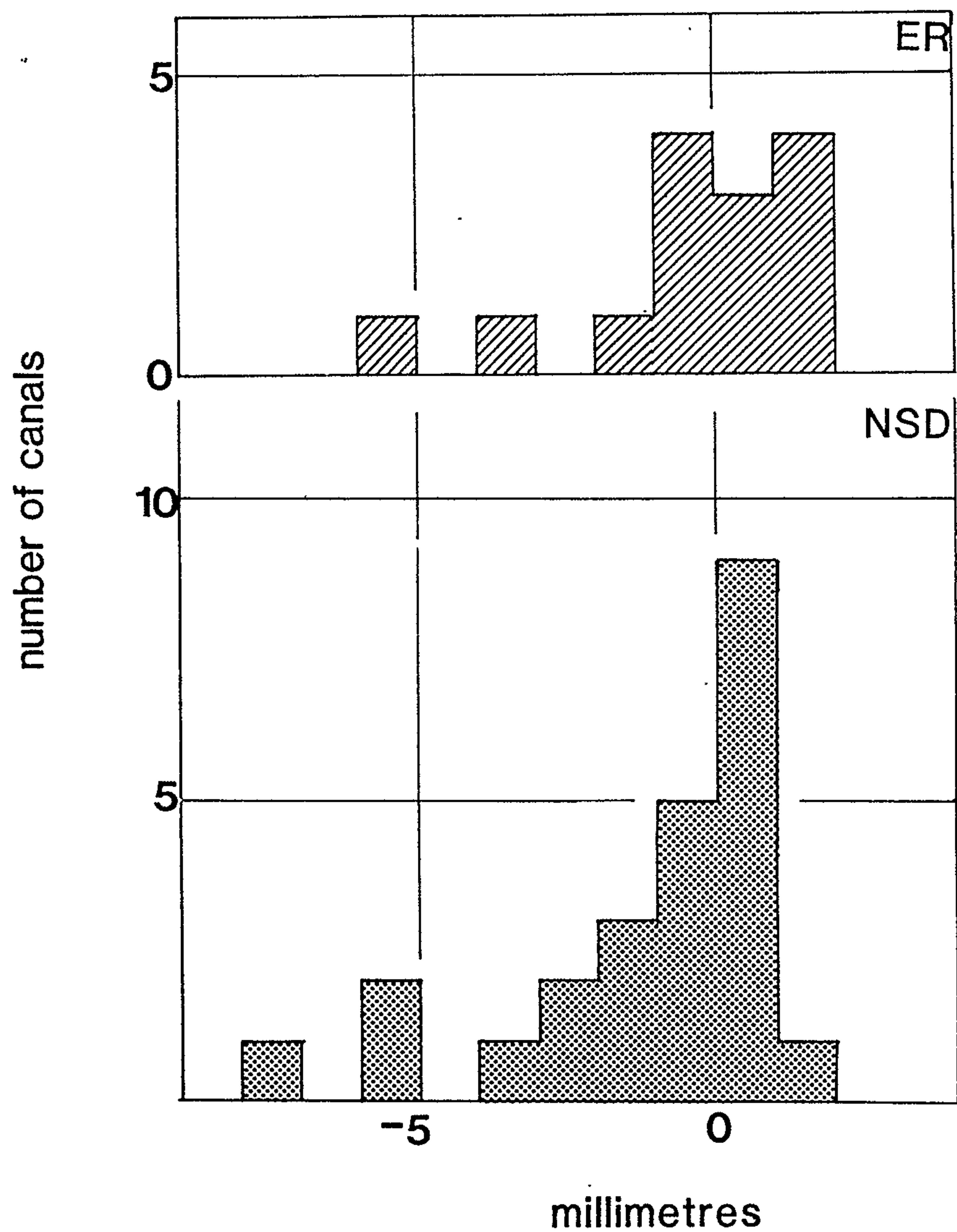


FIGURE 9.4

Investigation A (Anatomic study) Canals associated with radiographic periapical change: Difference between indicated and measured canal lengths - Endo-Radar (upper) and Neo-Sono-D (lower). Standard deviation Endo-Radar: ± 2.31 , Neo-Sono-D: ± 2.57 .

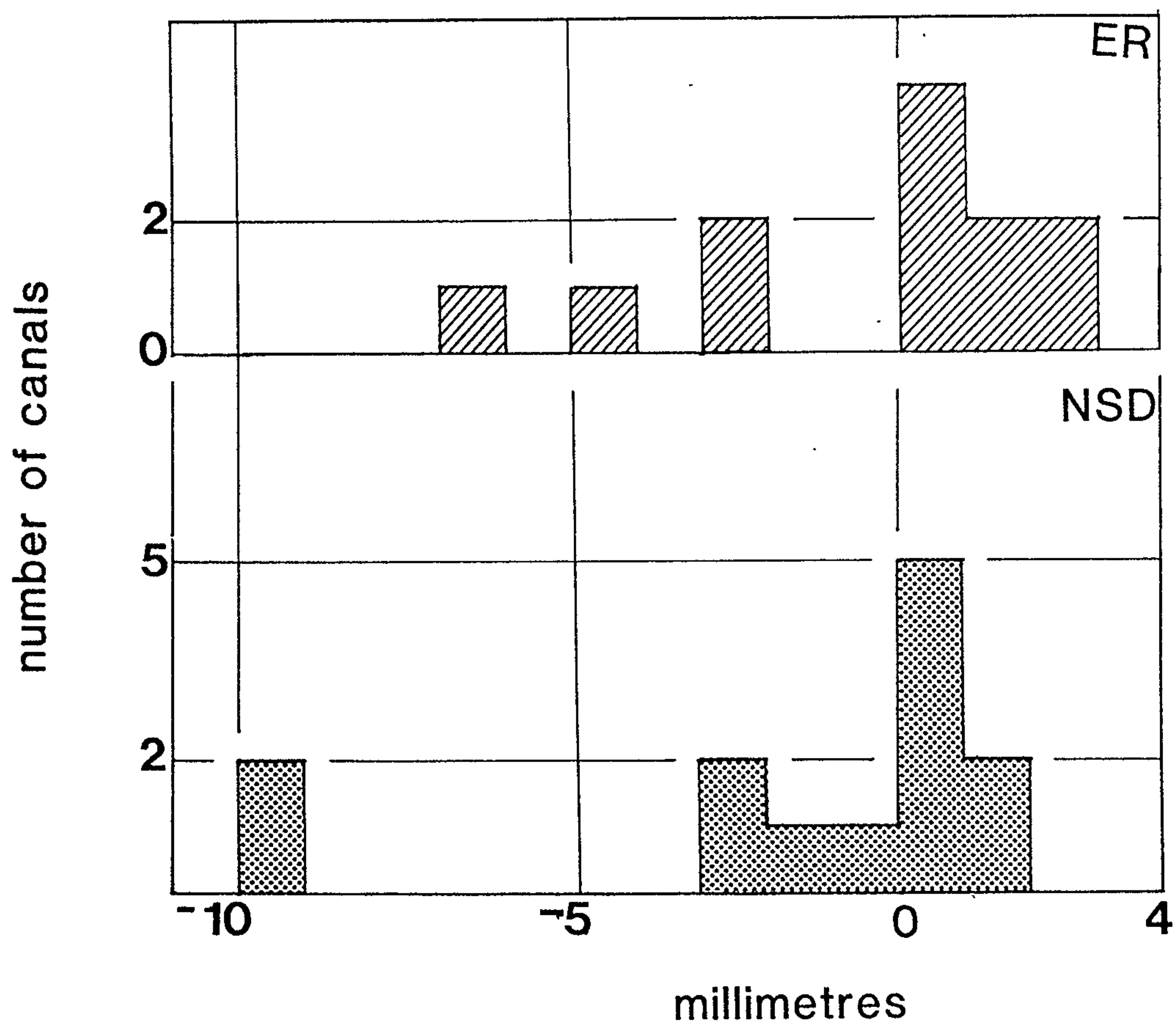


FIGURE 9.5

Investigation A (Anatomic study) Canals not associated with radiographic periapical change: Difference between indicated and measured canal lengths - Endo-Radar (upper) and Neo-Sono-D (lower). Standard deviation Endo-Radar: ± 2.28 , Neo-Sono-D: ± 3.04 .

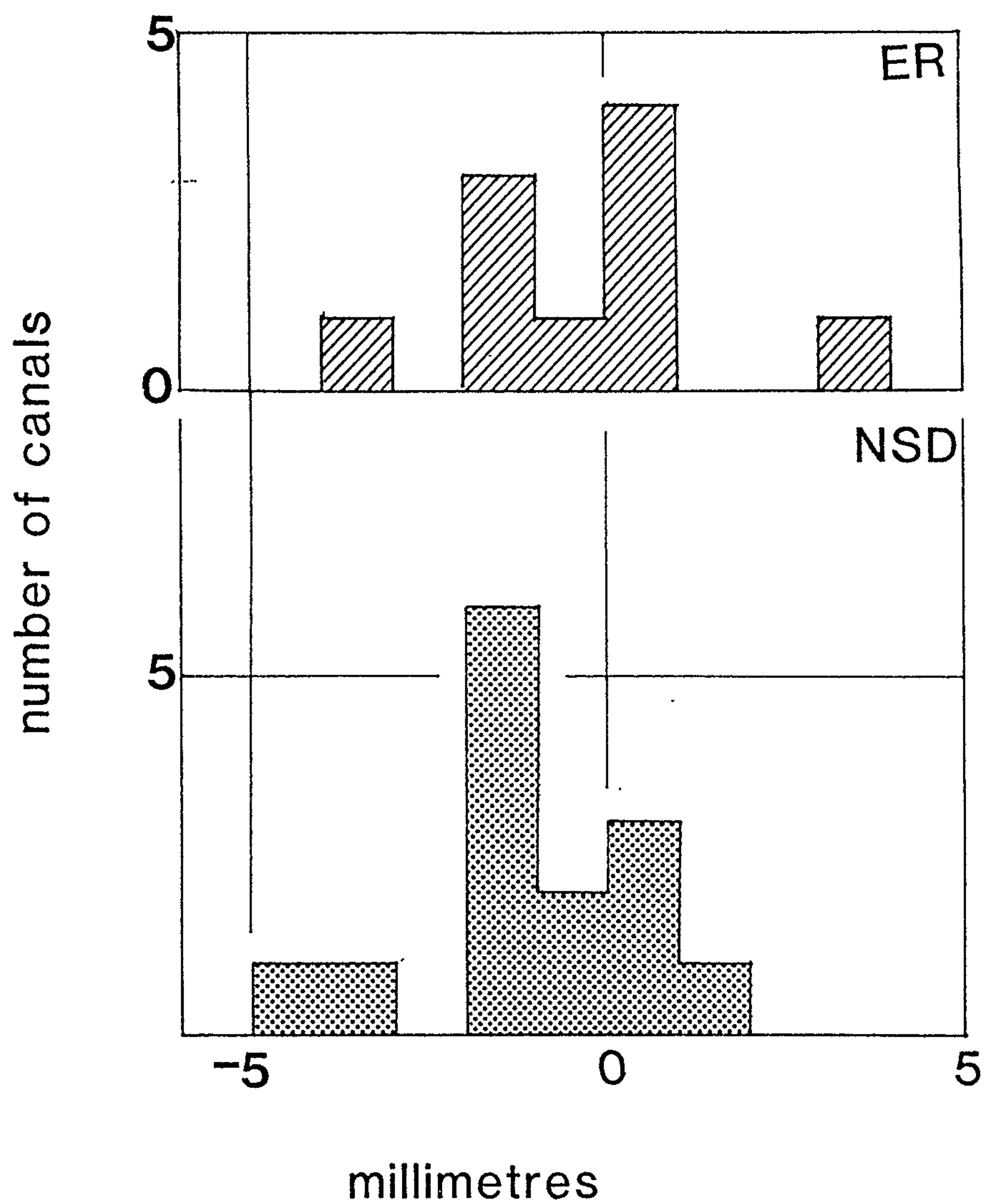


FIGURE 9.6

Investigation B (Clinical study) Difference between indicated length and radiographic position of the apex/foramen for those canals assessed as containing vital pulp tissue and measured with the Endo-Radar (upper) and Neo-Sono-D (lower). Standard deviation Endo-Radar: ± 1.65 , Neo-Sono-D: ± 1.38 .

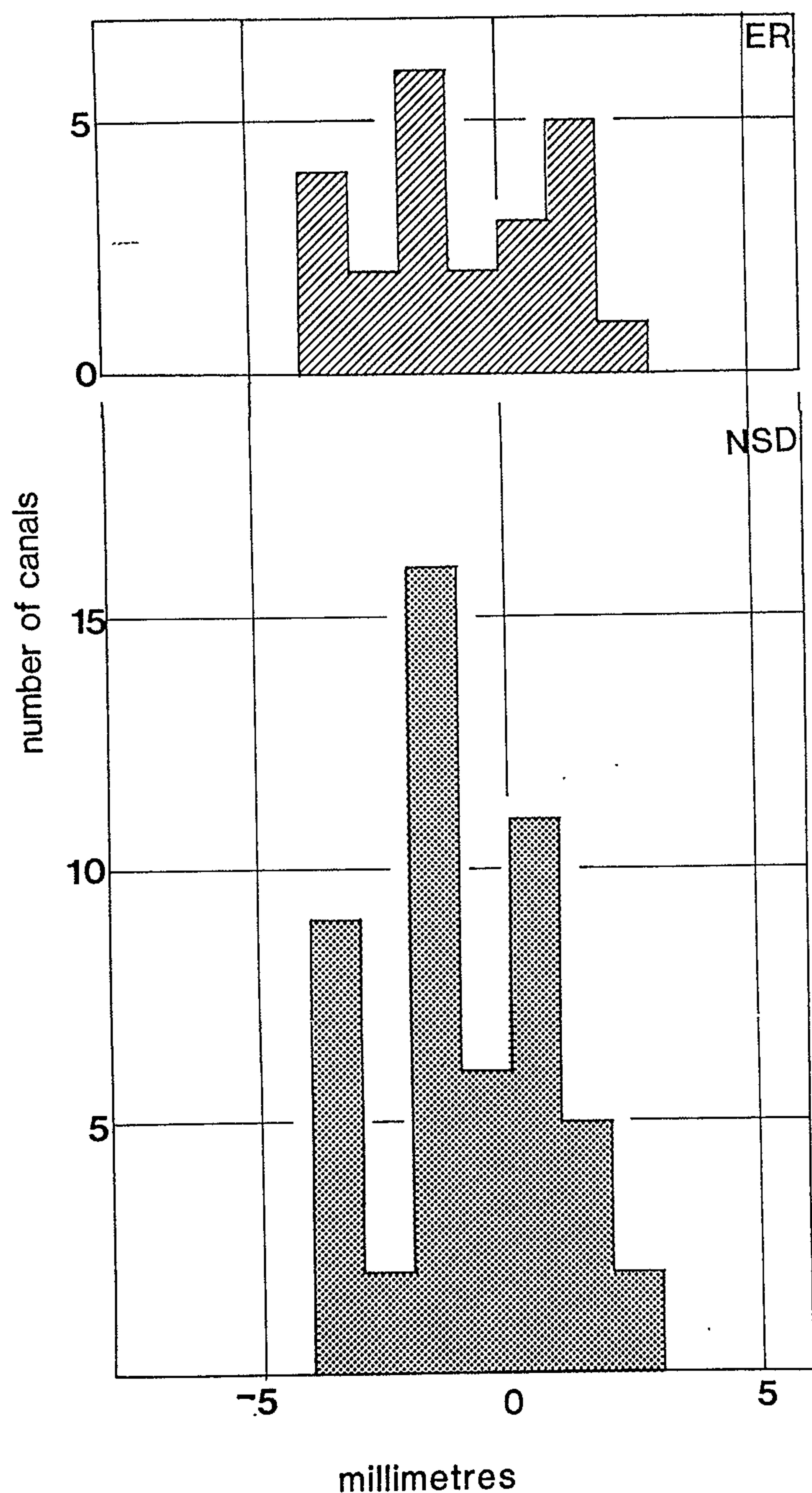


FIGURE 9.7

Investigation B (Clinical study) Difference between indicated length and radiographic position of the apex/foramen for those canals assessed as containing non-vital pulp tissue and measured with the Endo-Radar (upper) and the Neo-Sono-D (lower). Standard deviation Endo-Radar: ± 1.63 , Neo-Sono-D: ± 1.55 .

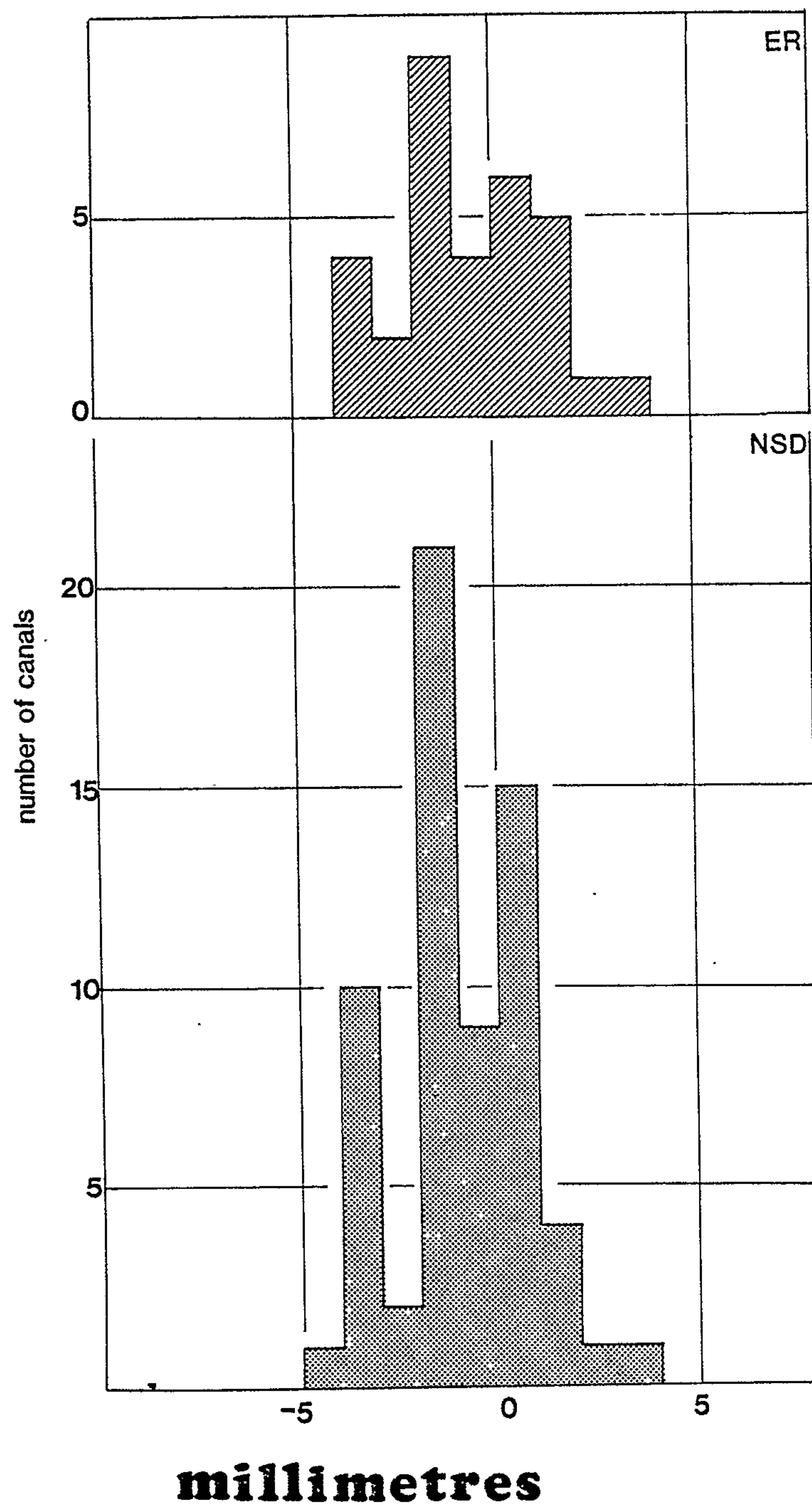


FIGURE 9.8

Investigation B (Clinical study). Difference between indicated length and radiographic position of the apex/foramen for all canals measured with the Endo-Radar (upper) and the Neo-Sono-D (Lower). Standard deviation Endo-Radar: ± 1.64 , Neo-Sono-D: ± 1.51 .

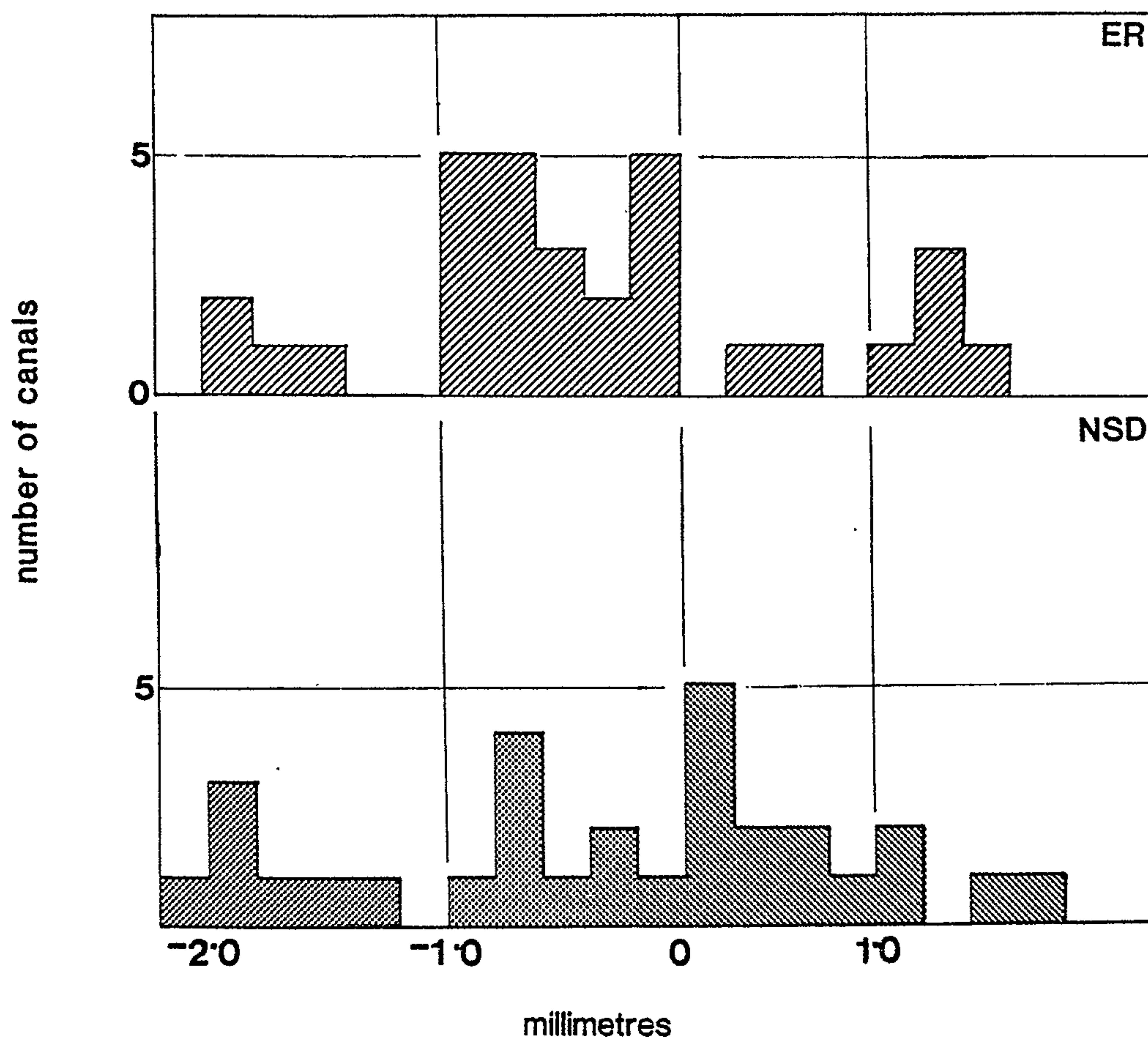


FIGURE 9.10

Investigation B (Clinical study) Difference between indicated length and radiographic position of the apex/foramen for those canals not associated with radiographic periapical change measured with the Endo-Radar (upper) and the Neo-Sono-D (lower). Standard deviation Endo-Radar: ± 1.43 , Neo-Sono-D: ± 1.48 .

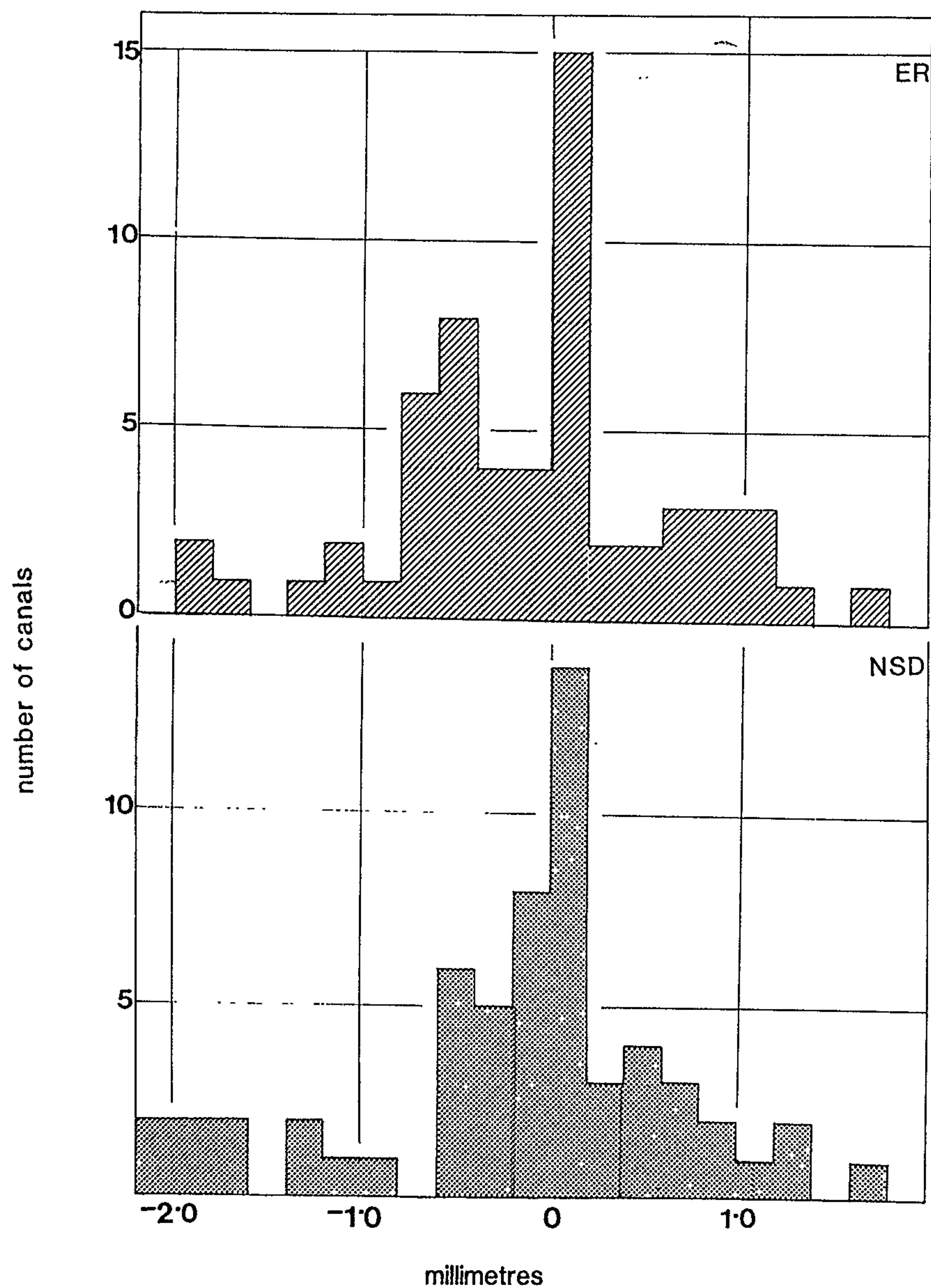


FIGURE 9.11

Investigation C (Laboratory study). Difference between indicated position and radiographic instrument position for all canals measured with the Endo-Radar (upper) and the Neo-Sono-D (lower). Standard deviation Endo-Radar: ± 0.73 , Neo-Sono-D: ± 0.77 .

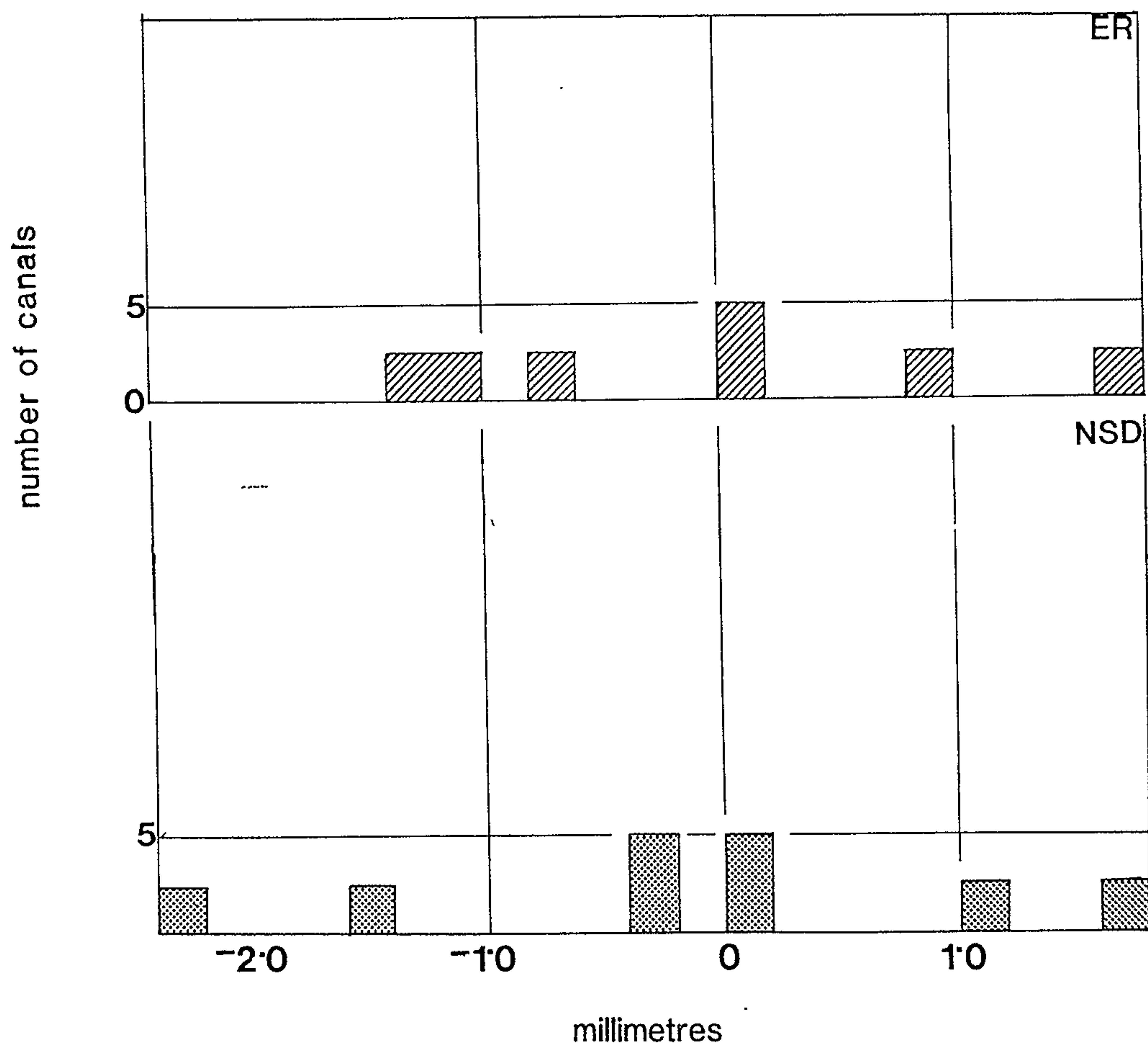


FIGURE 9.12

Investigation C (Laboratory study). Difference between indicated instrument position and radiographic instrument position for all canals classified as "Ax" and measured with the Endo-Radar (upper) and the Neo-Sono-D (lower). Standard deviation Endo-Radar: ± 0.94 , Neo-Sono-D: ± 1.14 .

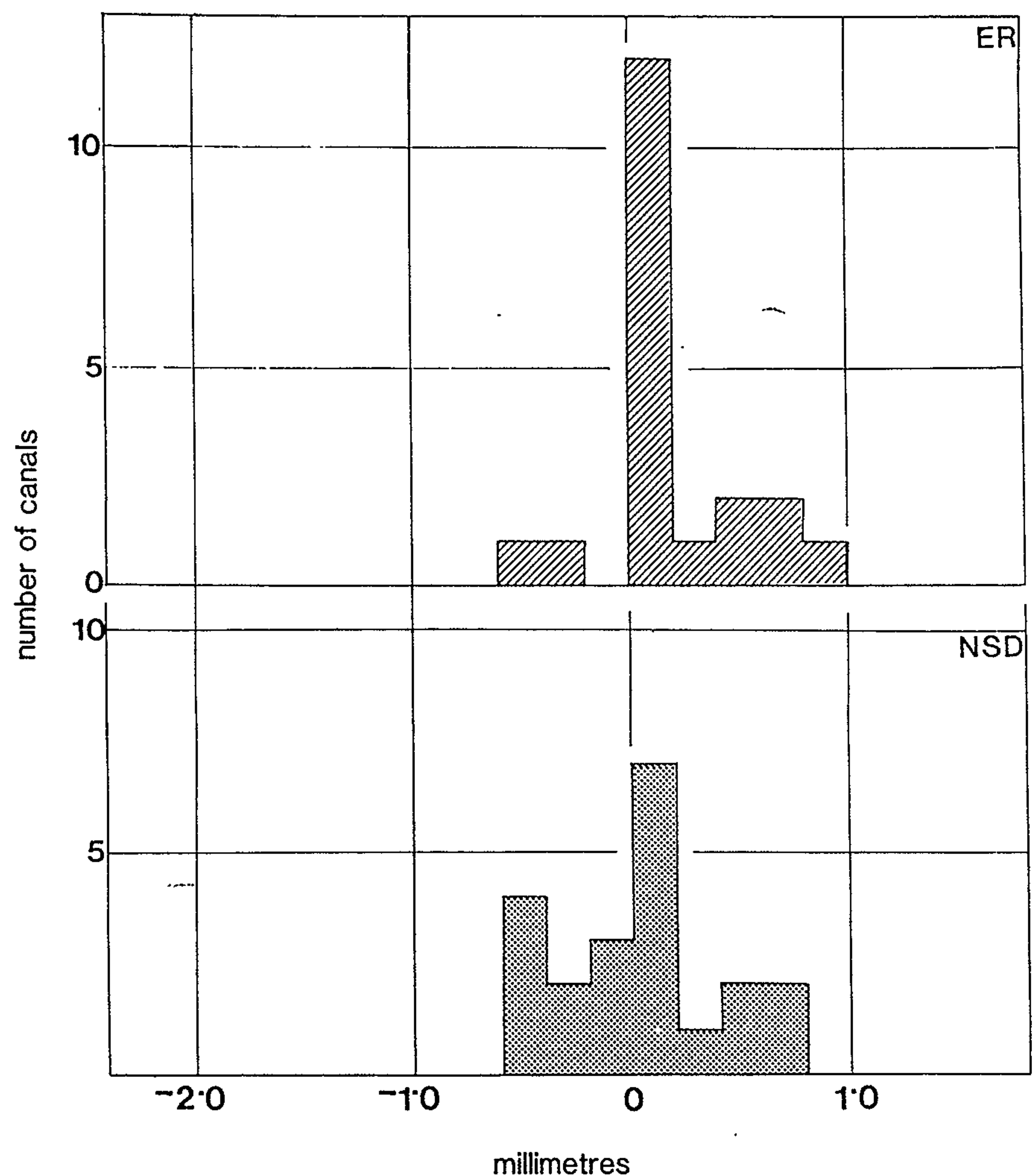


FIGURE 9.13

Investigation C (Laboratory study). Difference between indicated instrument position and radiographic instrument position for all canals classified as "Ay" (upper) and the Neo-Sono-D (lower) and measured with the Endo-Radar (upper). Standard deviation Endo-Radar: ± 0.33 , Neo-Sono-D: ± 0.30 .

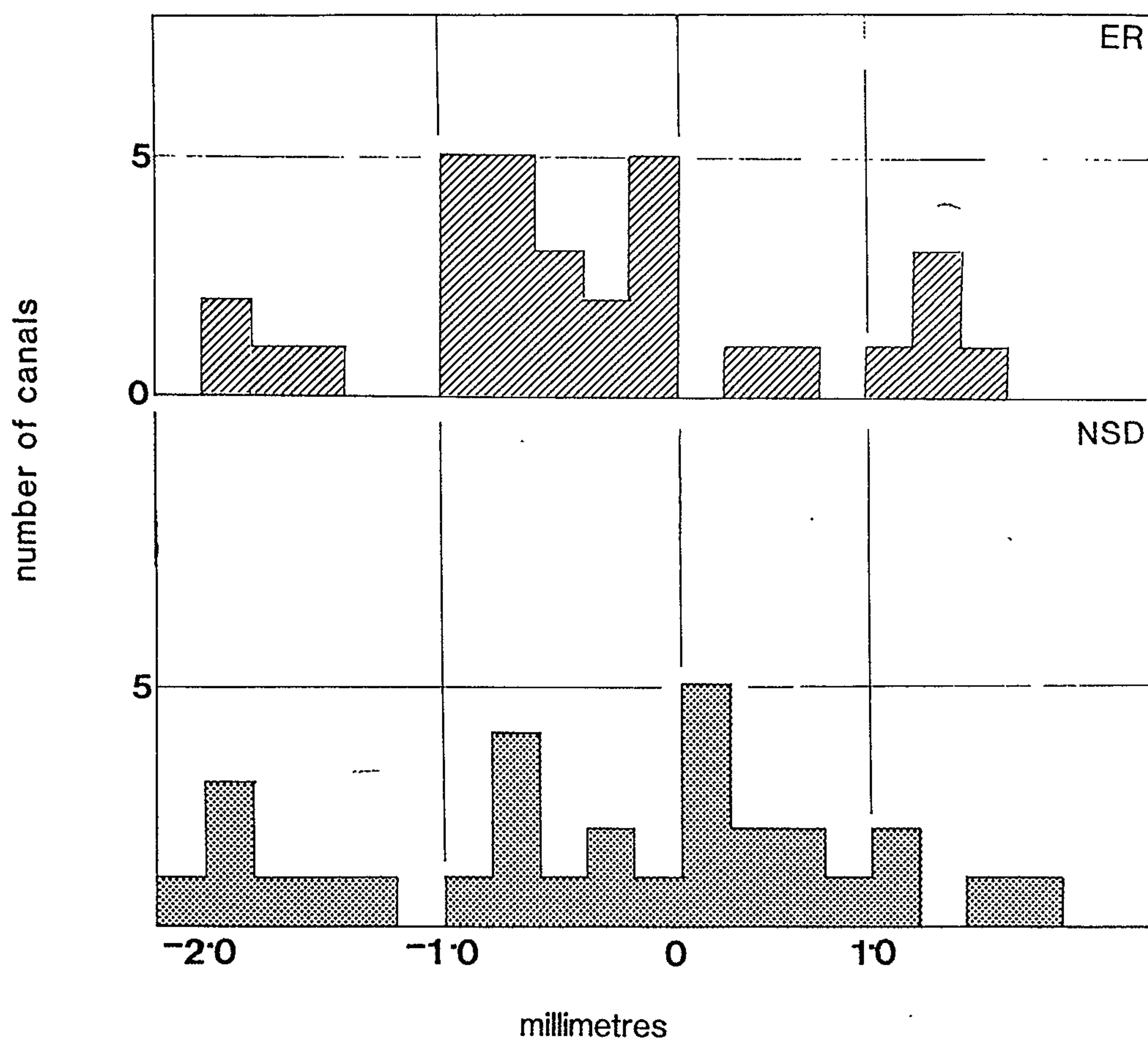


FIGURE 9.14

Investigation C (Laboratory study). Difference between indicated instrument position and radiographic instrument position for all canals classified as "Bx" and measured with the Endo-Radar (upper) and the Neo-Sono-D (lower). Standard deviation: Endo-Radar ± 0.82 , Neo-Sono-D ± 1.14 .

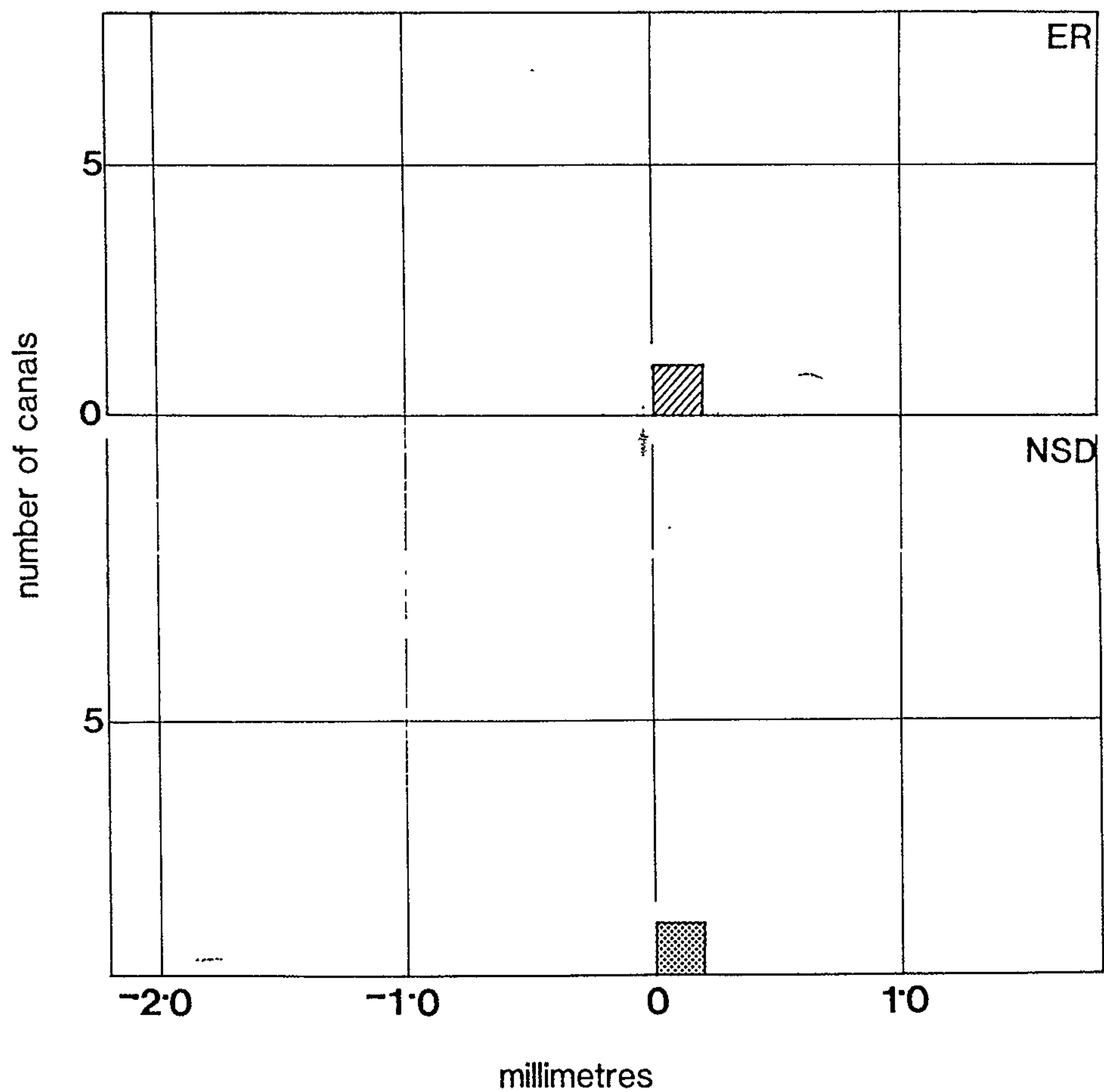


FIGURE 9.15

Investigation C (Laboratory study). Difference between indicated instrument position and radiographic instrument position for all canals classified as "By" and measured with the Endo-Radar (upper) and the Neo-Sono-D (lower). Standard deviation: not computer due to small sample size.

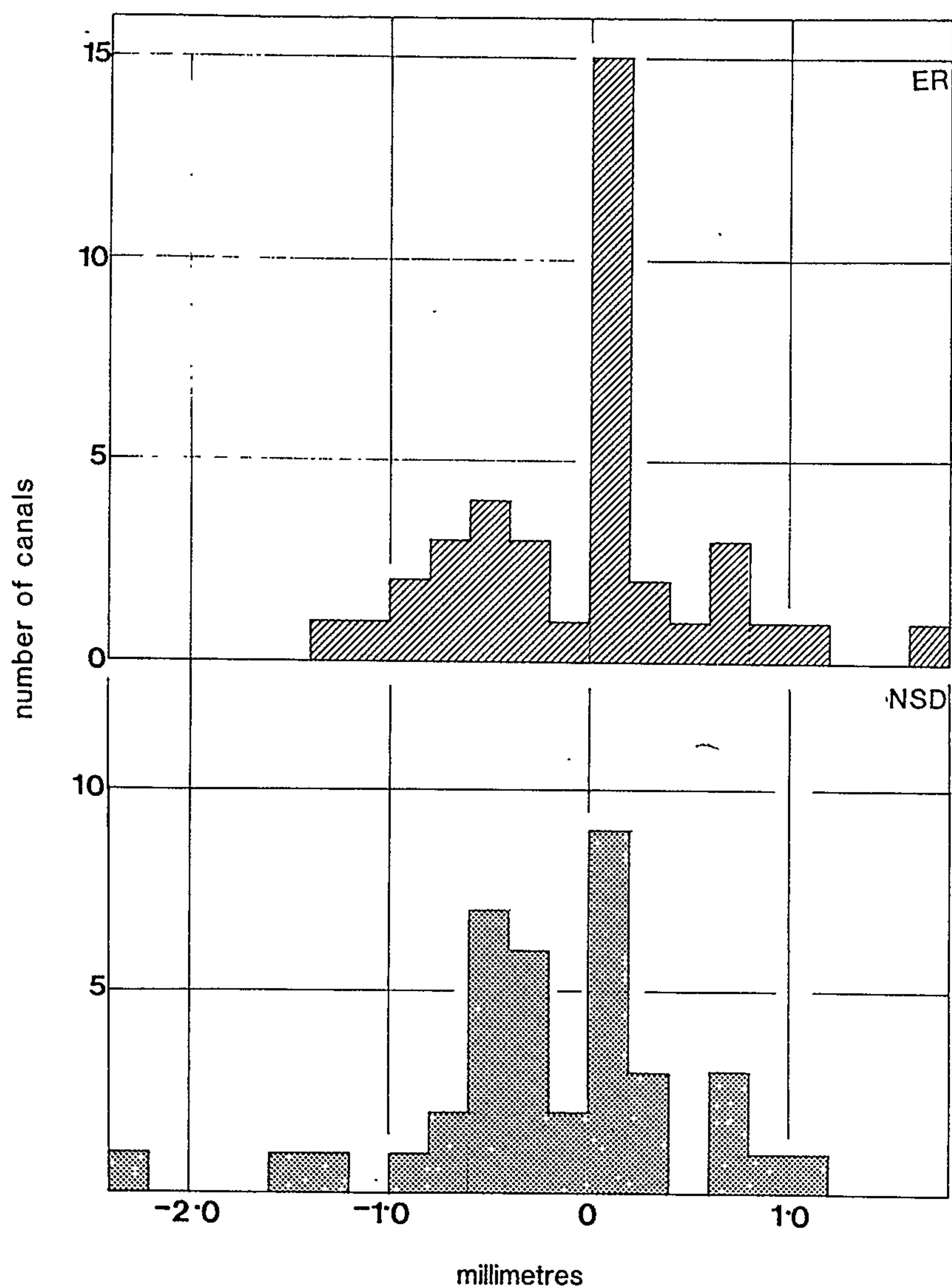


FIGURE 9.16

Investigation C (Laboratory study). Difference between indicated instrument position and radiographic instrument position for canals stored in tapwater and measured with the Endo-Radar (upper) and the Neo-Sono-D (lower). Standard deviation Endo-Radar: ± 0.55 , Neo-Sono-D: ± 0.62 .

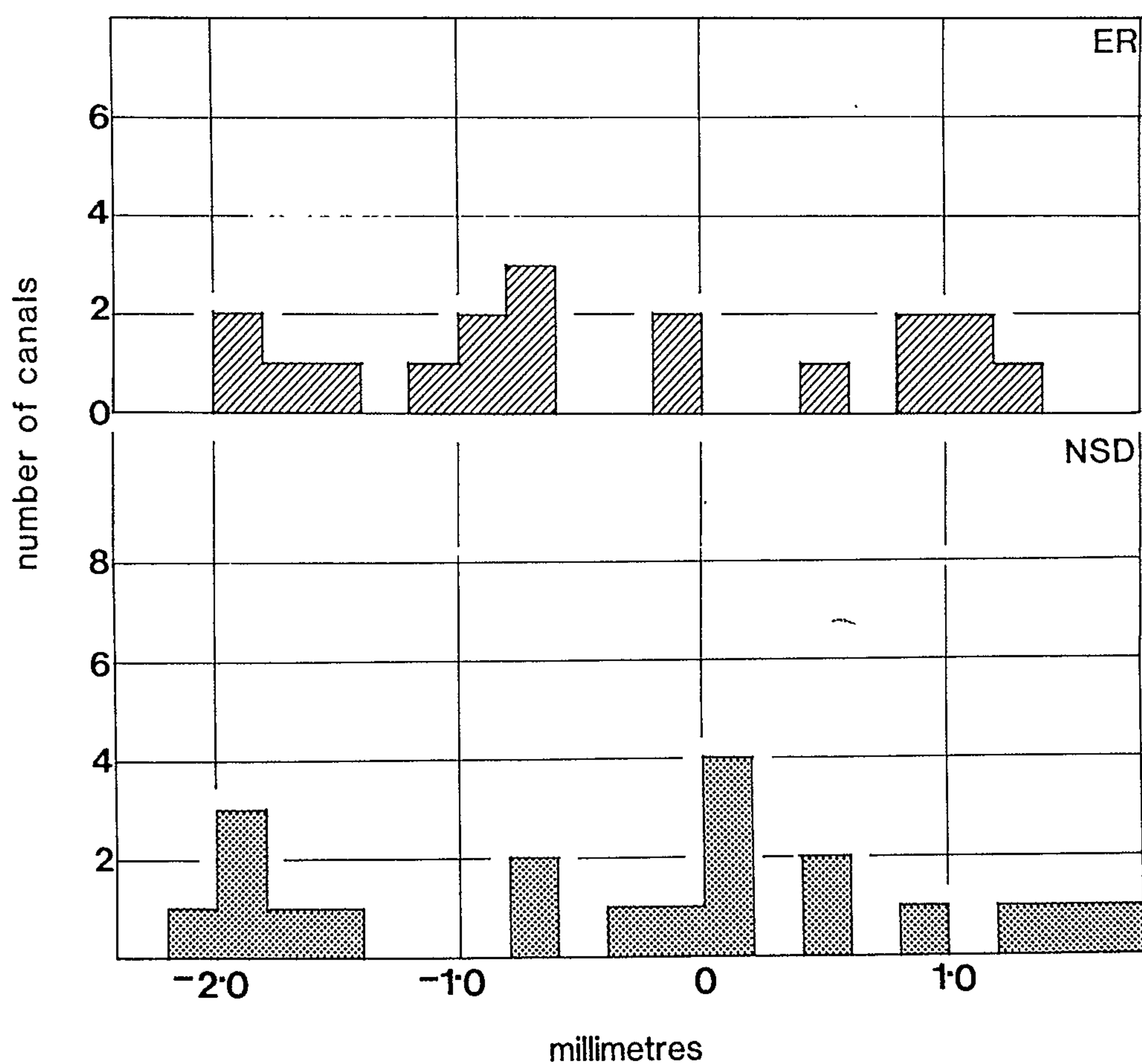


FIGURE 9.17

Investigation C (Laboratory study). Difference between indicated instrument position and radiographic instrument position for canals stored in formalin and measured with the Endo-Radar (upper) and the Neo-Sono-D (lower). Standard deviation Endo-Radar: ± 0.97 , Neo-Sono-D ± 1.14 .

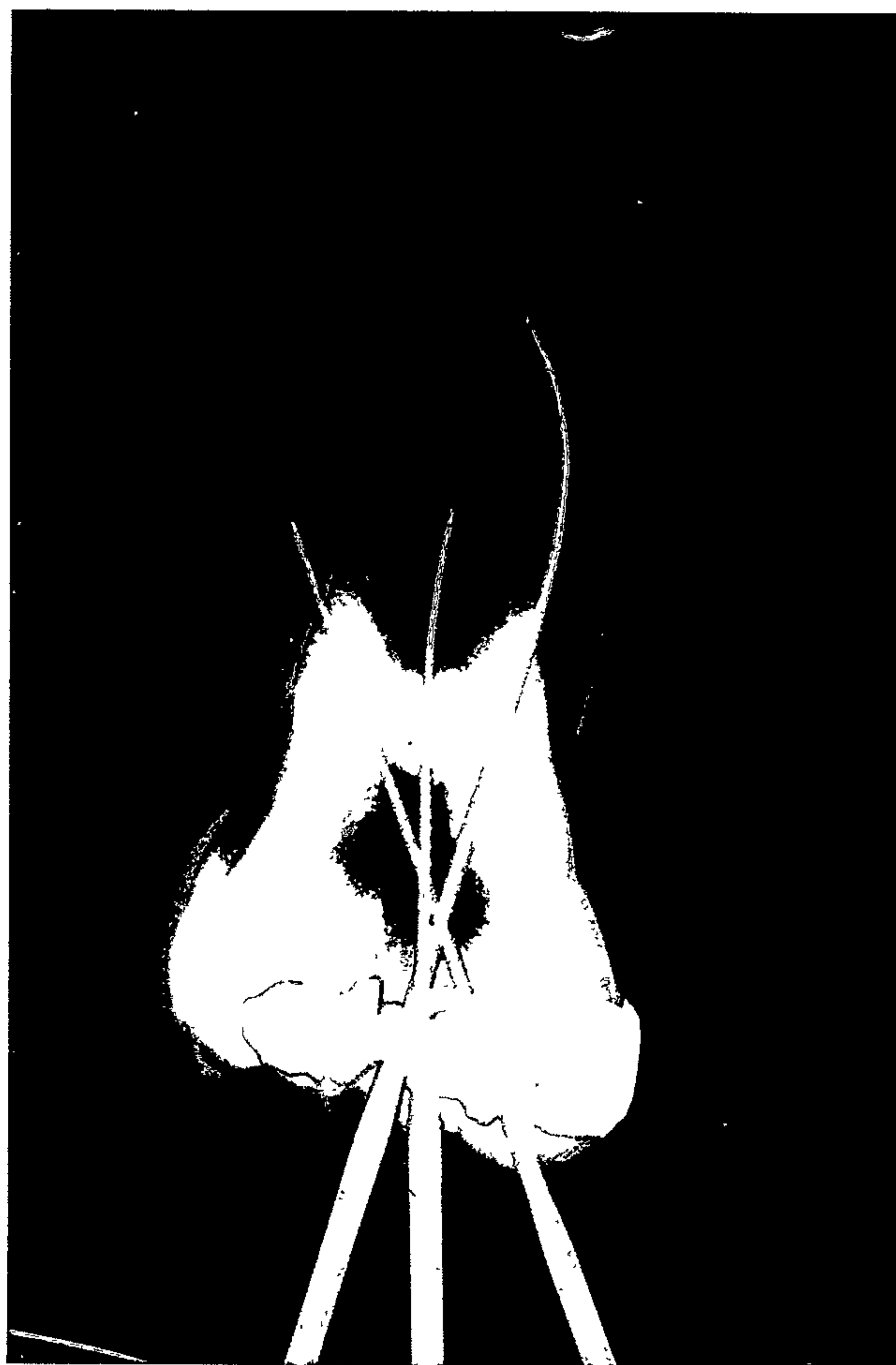
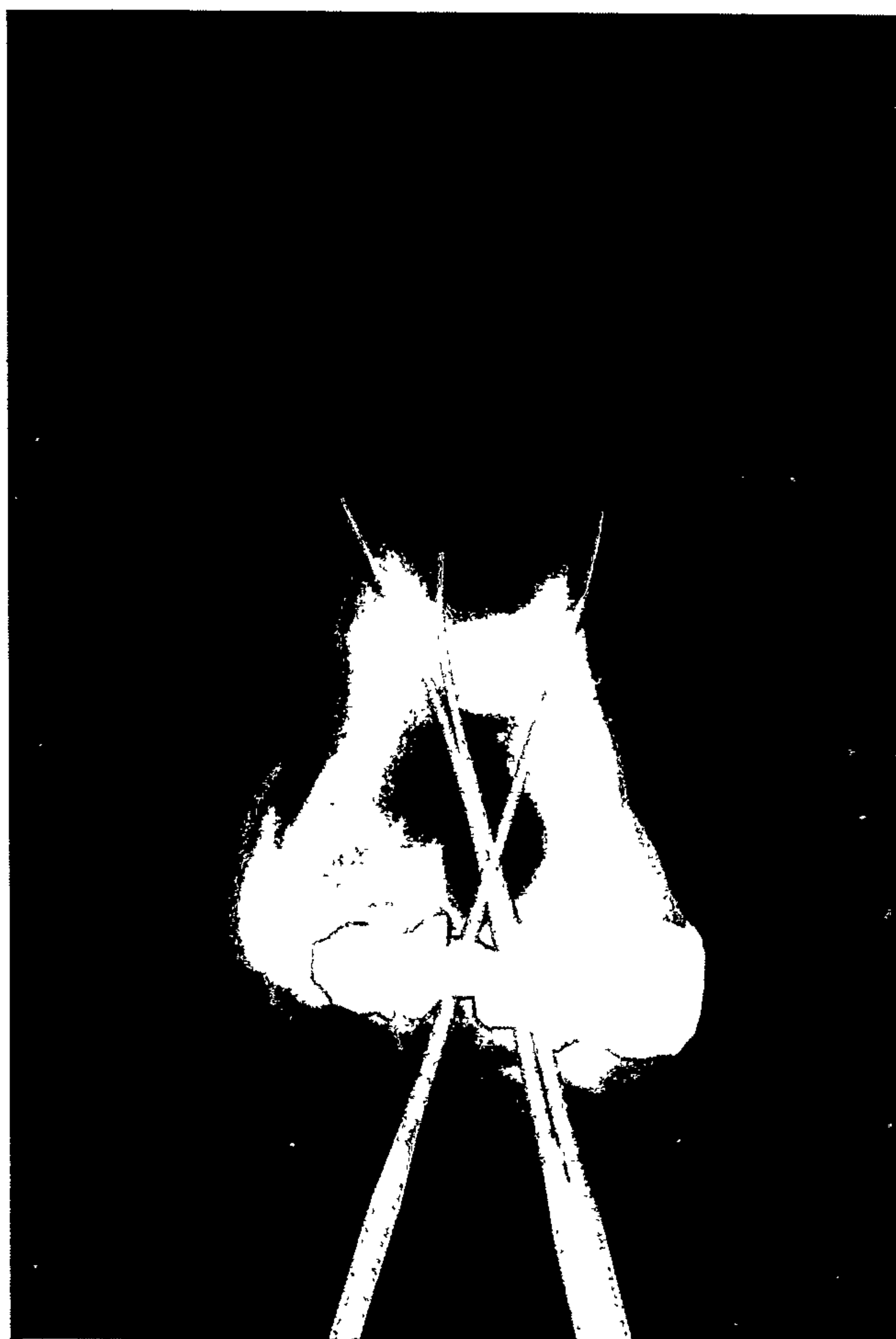


FIGURE 10.1

Case 4, Anatomic study (Investigation A): Tooth 16

To left: at these lengths, mesio-buccal 20.5mm, disto-buccal 16.5mm, palatal 19mm Endo-Radar read 0.4 short, 0.0, and 0.1 short respectively.

To right: at these lengths, mesio-buccal 15mm, disto-buccal 16mm, palatal 14mm Neo-Sono-D digital display indicated 0.3 long, 0.4-0.5 long, 1.5 long respectively. Canal contents - hemorrhagic pulp tissue controlled with hydrogen peroxide and paper points. "Long" readings obtained with Neo-Sono-D did not change when instruments were slowly withdrawn from the canal.

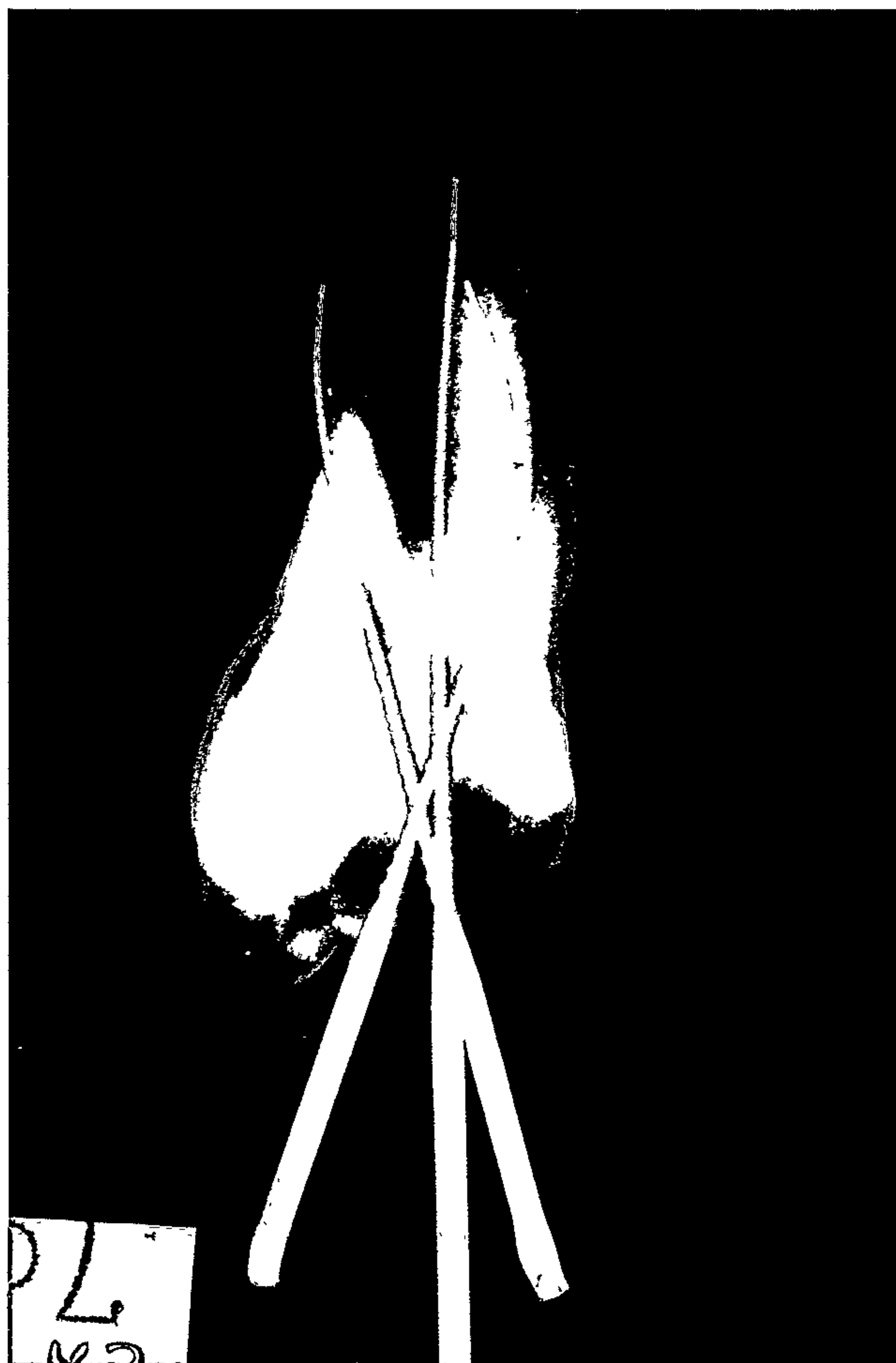
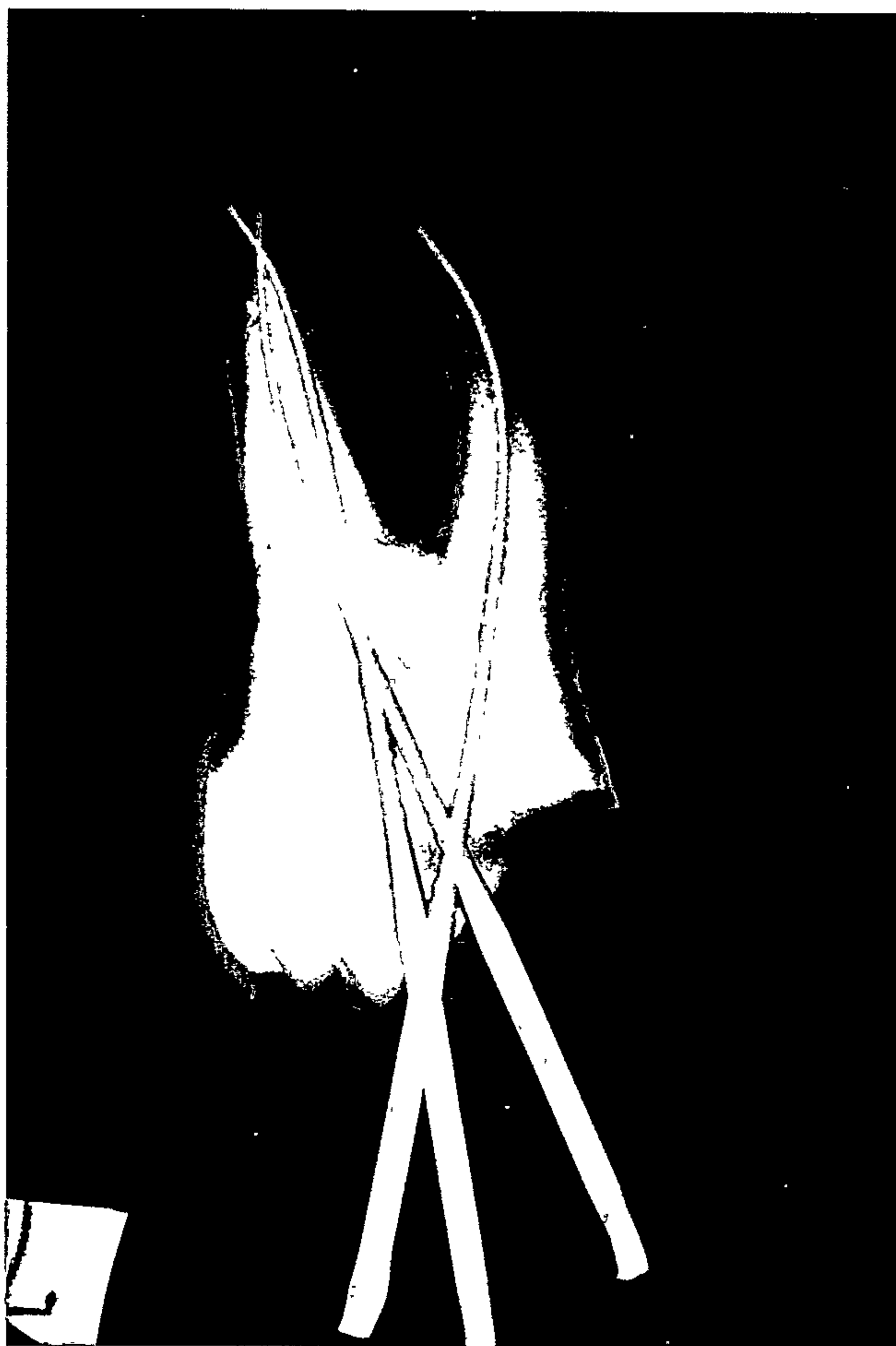


FIGURE 10.2

Case 7, Anatomic study (Investigation A): Tooth 16:

To left: at these lengths, mesio-buccal 20.5mm, disto-buccal 20mm, palatal 22mm Endo-Radar gave a digital display of "0.0" in each canal.

To right: at these lengths mesio-buccal 20mm, disto-buccal 19mm, palatal 21mm Neo-Sono-D gave a digital display of "0.0" in each canal. Canal contents: non-vital pulp tissue present - no exudate.

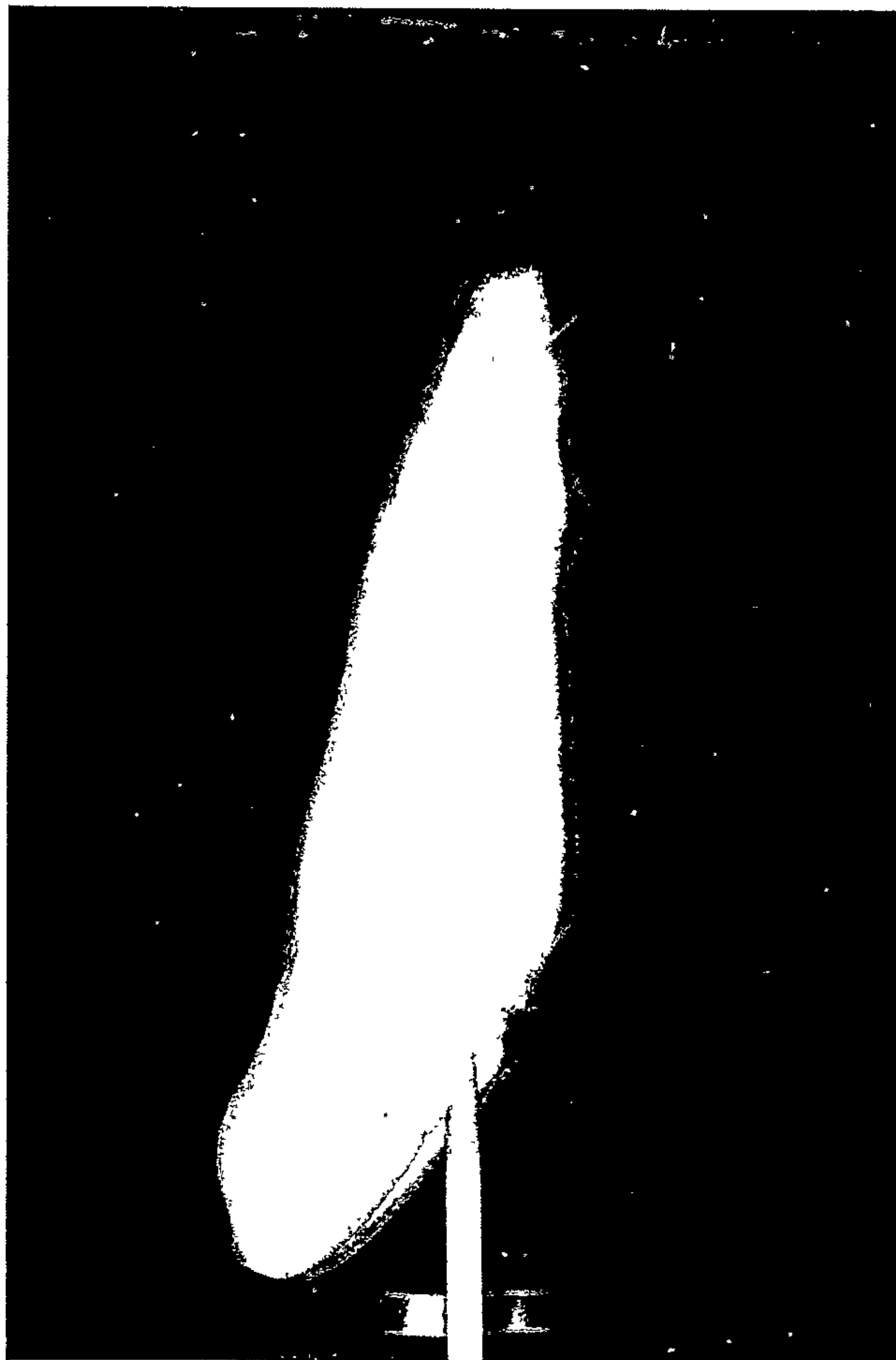


FIGURE 10.3

Case 14, Anatomic study (Investigation A): Tooth 13: in this canal the Neo-Sono-D digital display fluctuated between "0.0" and "+0.1" - at the same length the Endo-Radar would not give a reading. Canal contents - canal space devoid of tissue.

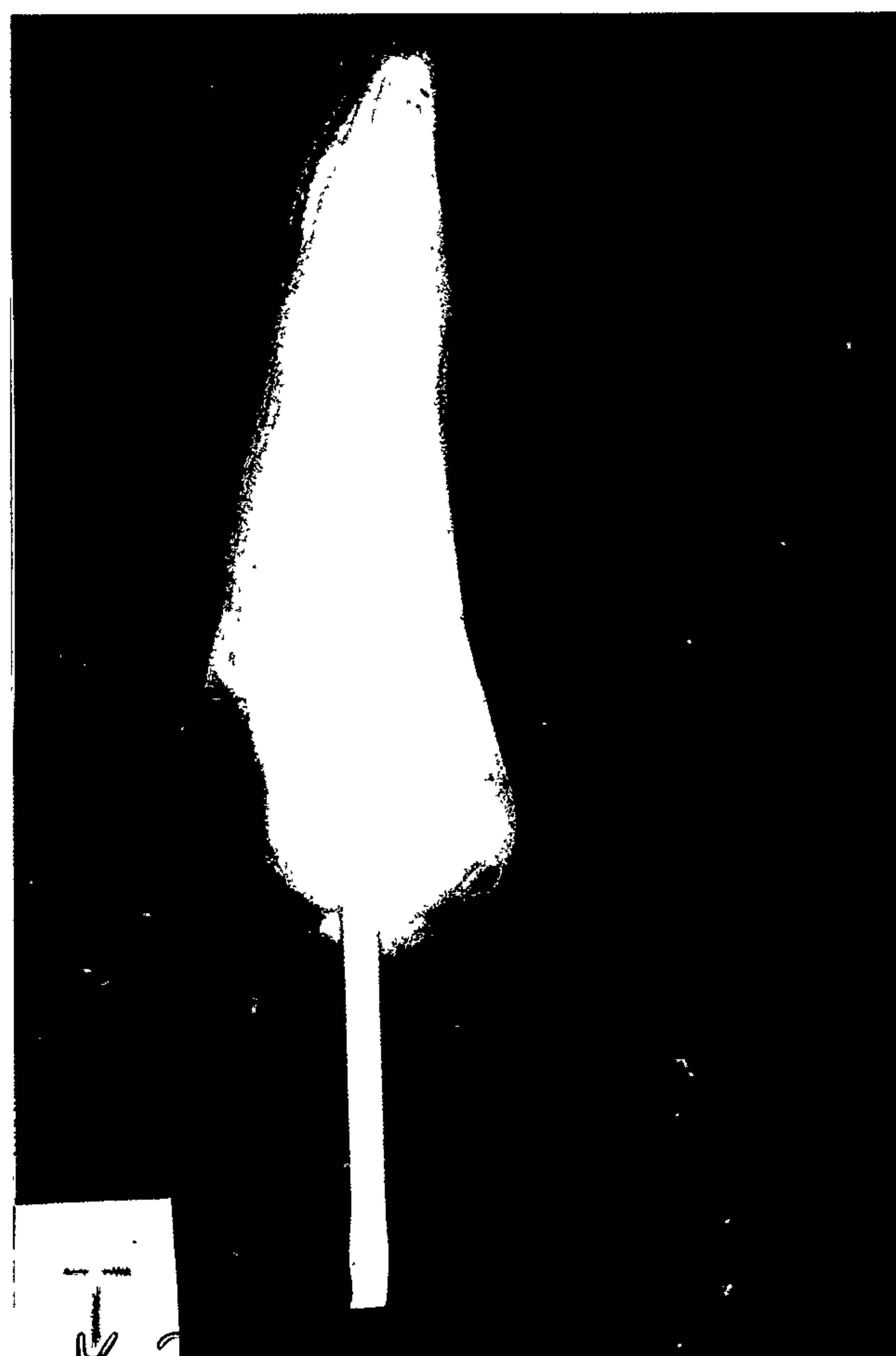
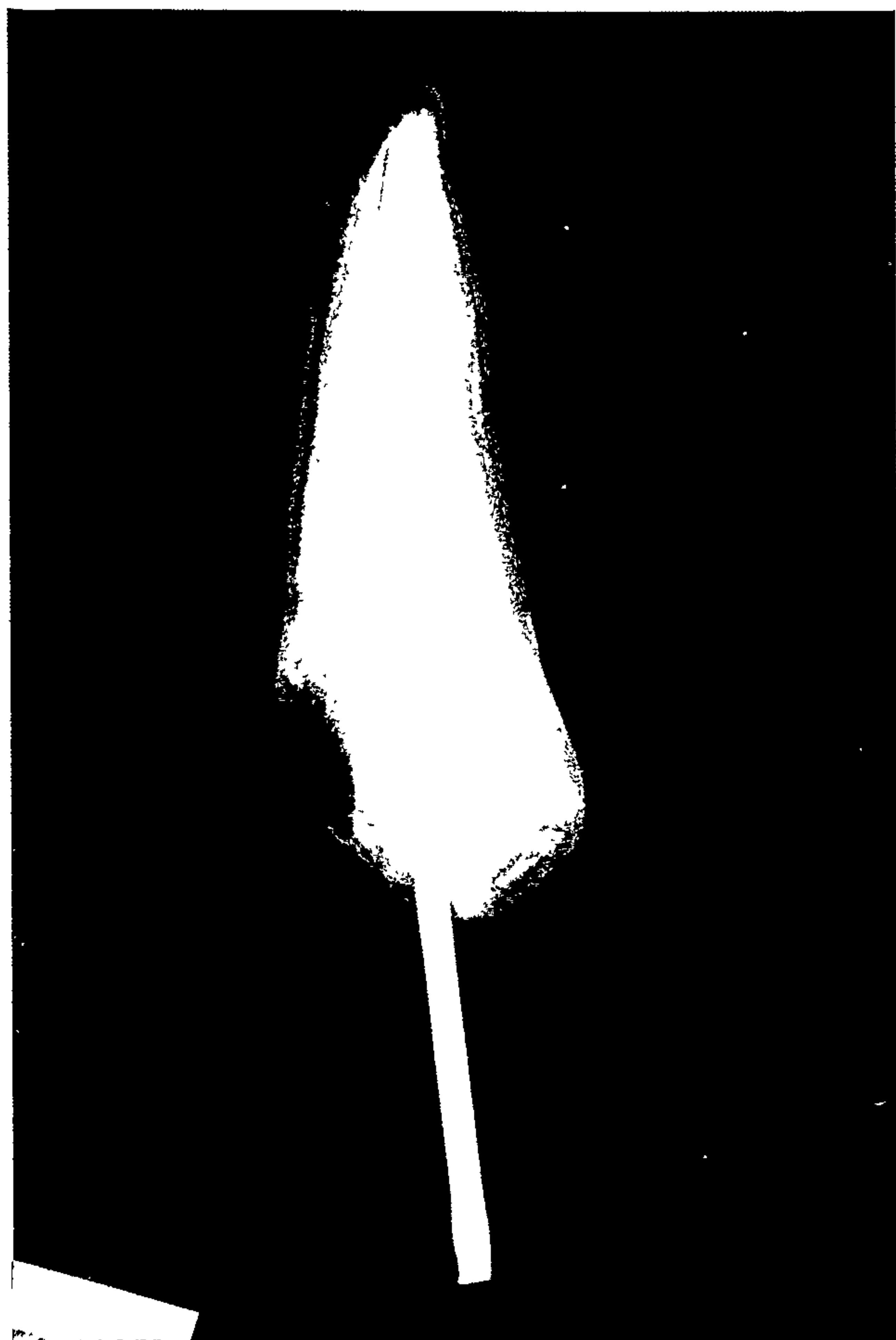


FIGURE 10.4

Case 16, Anatomic study (Investigation A): Tooth 15:
 To left: Endo-Radar digital display "0.0" at 18 millimetres
 To right: Neo-Sono-D digital display "+0.9" to "+1.0" at 19
 millimetres. Canal contents - vital tissue present.

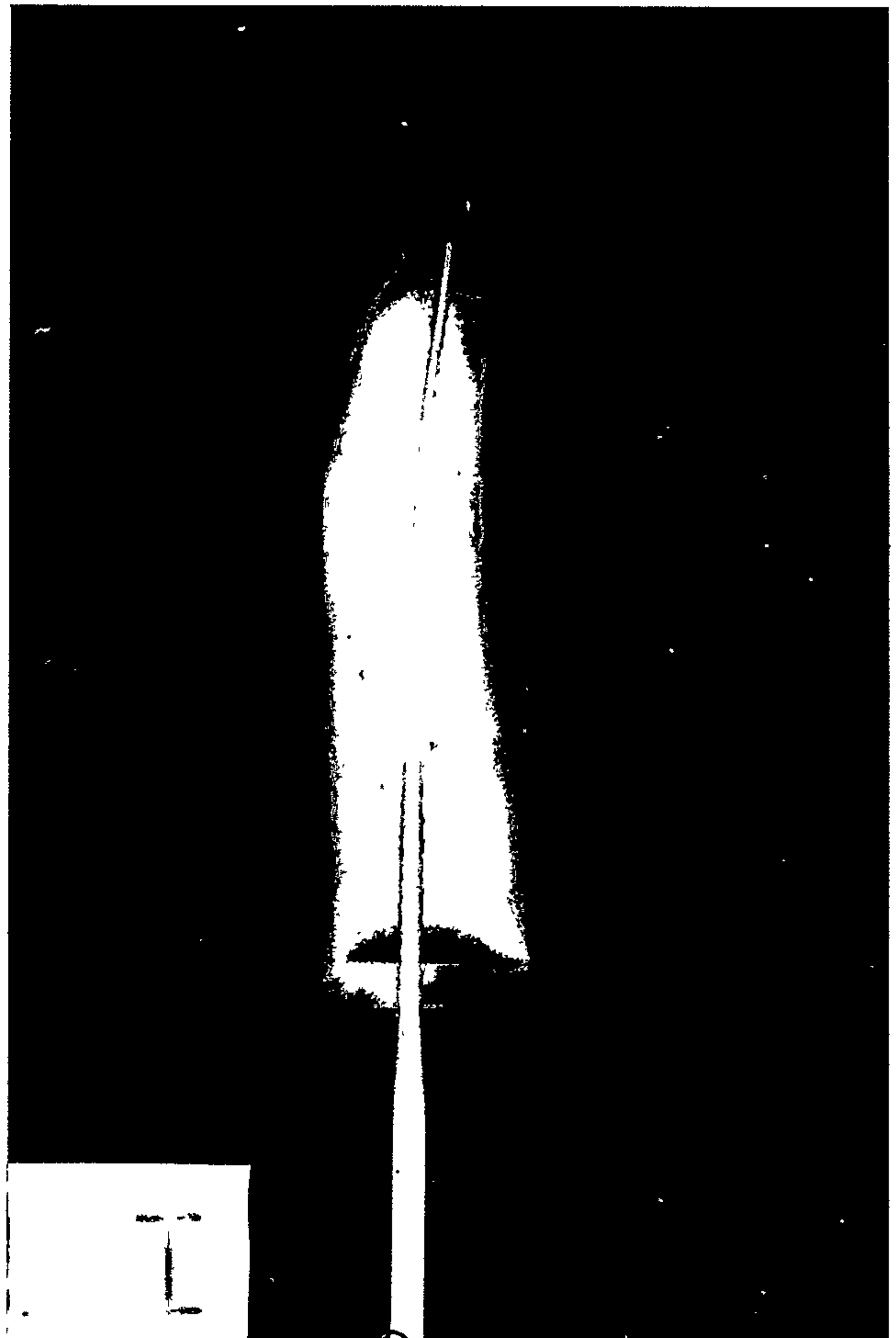
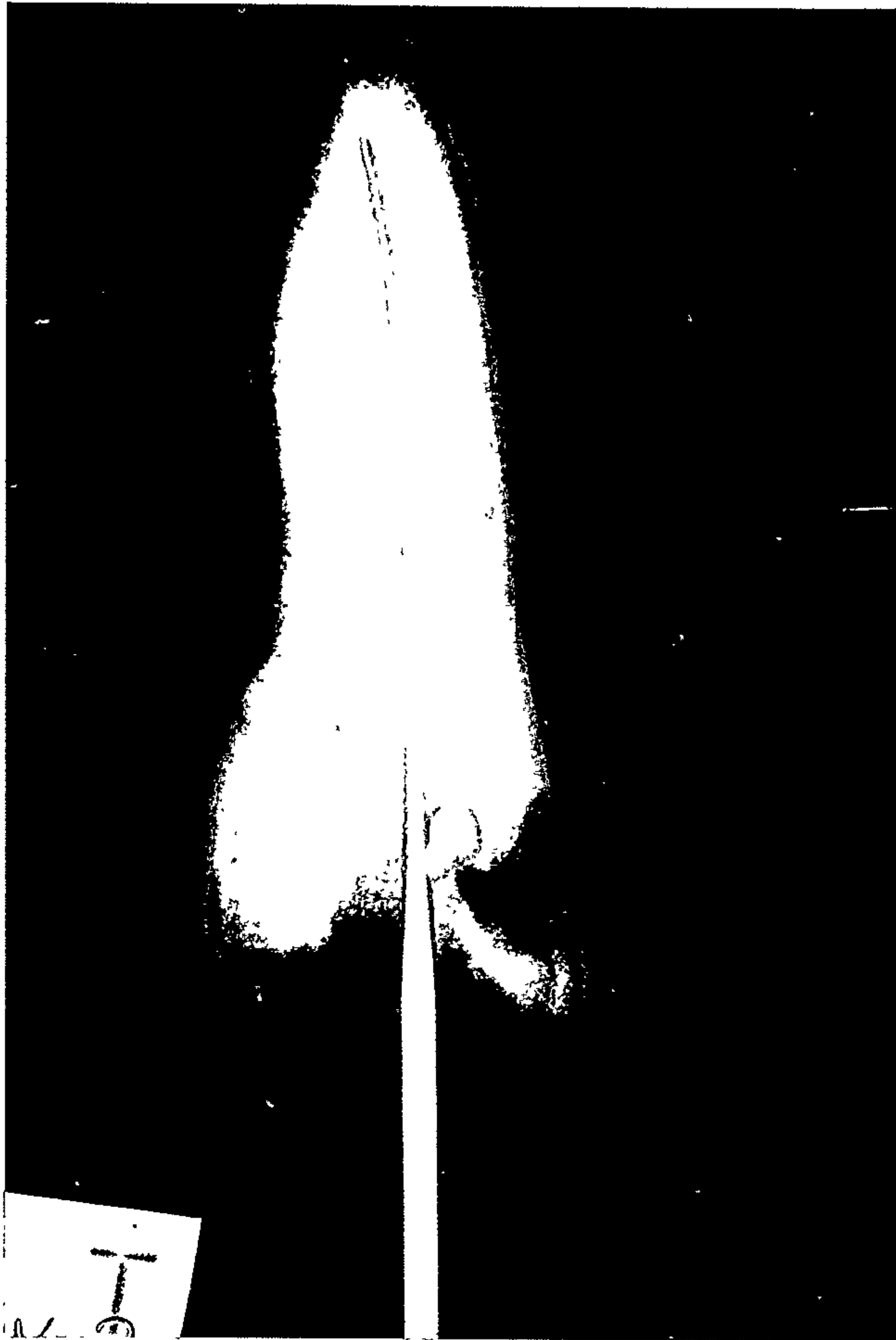


FIGURE 10.5

Case 18a, Anatomic study (Investigation A):

To left: Tooth 11: Endo-Radar would not register a digital display at 22 mm. At the same length Neo-Sono-D gave digital display of 1.8 "short". Ledermix previously used in canal, but copious irrigation with hydrogen peroxide before either device used.

To right: case 18b, Tooth 12: same patient, same canal conditions, Endo-Radar would not register a reading, Neo-Sono-D registered instrument to be 0.8 millimetre short of the "apex" at 22 mm.

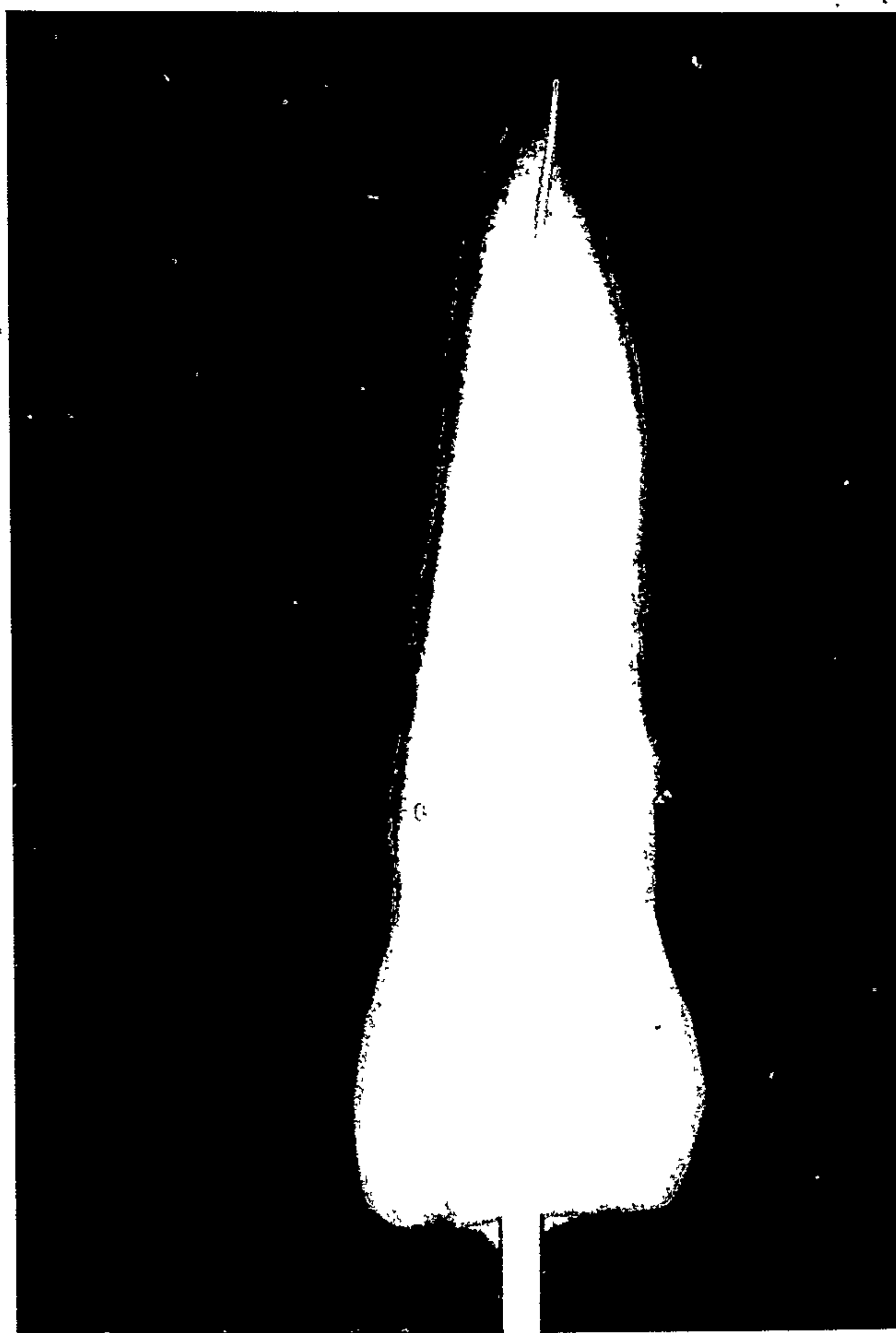
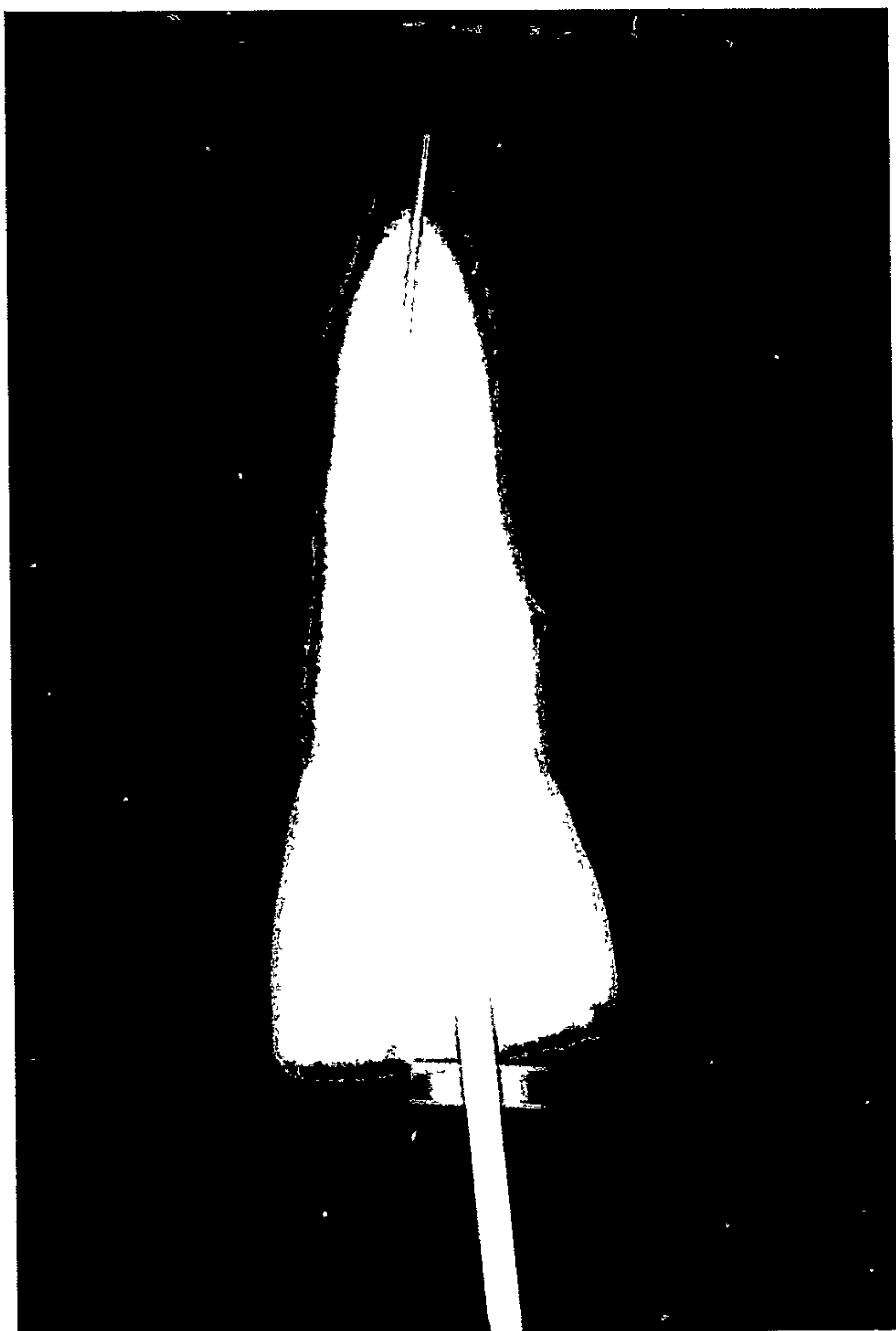


FIGURE 10.6

Case 22a, Anatomic study (Investigation A):

To left: Tooth 21: Endo-Radar could not be used due to periodontal disease. Neo-Sono-D with K-file at 23mm indicated the instrument to be 0.0 to 0.1mm beyond the foramen.

To right: case 22, Tooth 23: Anatomic study (Investigation A) Endo-Radar could not be used due to periodontal disease. At length 24.5mm the Neo-Sono-D digital display indicated the foramen had been reached.



FIGURE 10.7

Case 19, Clinical study (Investigation B): Teeth 21, 22 previously root-filled in Vietnam with paste-type filling material. Large periapical radiolucencies present. Copious irrigation with hydrogen peroxide before instruments placed in canal. Tooth 21: both Endo-Radar and Neo-Sono-D indicated "apex" reached at 16mm. Tooth 22: Endo-Radar would not give a display, Neo-Sono-D indicated "apex" reached at 14.5mm.



FIGURE 10.8

Case 21, Clinical study (Investigation B): Tooth 46 previously paste filled. Endo-Radar indicated mesio-buccal canal 0.1 long at 17mm, mesio-lingual canal 0.2 long at 18mm and distal canal 0.8 long at 17mm - a larger diameter instrument in distal canal indicated the instrument to be 0.2mm short of the apex at 15mm. Hydrogen peroxide used prior to electronic measurements taken.



FIGURE 10.9

Case 11, Clinical study (Investigation B): Tooth 13: Initial file placement, no pulp extirpation attempted. At the radiographed length (24.5mm) Endo-Radar indicated the "apex" had been reached. At the same length the Neo-Sono-D indicated file to be 0.6mm beyond the "apex".



FIGURE 10.10

Case 16, Clinical study (Investigation B): Tooth 21: Apex not closed. At the file position shown above the Endo-Radar would not register a reading, whereas the Neo-Sono-D indicated the instrument to be at the apex and fluctuating 0.1mm beyond the apex. Display took approximately 30 seconds to stabilize. Ledermix was found in the apical tissue.



FIGURE 10.11

Case 12, Clinical study (Investigation B): Tooth 21:

Left: In this canal, Endo-Radar would not give a reading, but the Neo-Sono-D indicated the instrument to be 0.4-0.6mm beyond the "apex" at 20mm. This reading was erratic and difficult to stabilize. A "0.0" display occurred intermittently at 20mm. Chloroform had been used to remove an inadequate gutta percha filling. Hydrogen peroxide had been used to neutralize the chloroform.

Right: Case 12, Clinical study (Investigation B). With a much larger diameter instrument and several months later the Neo-Sono-D indicated a "0.0" reading at 17mm after drying with paper points following hydrogen peroxide irrigation. This canal was subsequently found to be perforated.



FIGURE 10.12

Case 6, Clinical study (Investigation B): Tooth 22:

Left: Endo-Radar indicated "apex" at 18mm. Neo-Sono-D indicated foramen position at same length. Canal had been previously root-filled, root-filling removed by another operator, canal empty when measurements taken.

Right: Case 6, one month later: Endo-Radar indicated instrument 1.5mm "long" at 20mm: at some length Neo-Sono-D indicated instrument to be 2.0-2.5mm beyond the "apex".



FIGURE 10.13

Case 26, Clinical study (Investigation B): Tooth 36: non-vital pulp tissue, only remnants of tissue remained. Endo-Radar indicated the "apex" had been reached at 22mm (upper), Neo-Sono-D gave a digital display of "0.1 short" to "0.0" (fluctuating) at 20mm (lower).



FIGURE 10.14

Case 27, Clinical study (Investigation B): Tooth 23: gutta percha filling removed with chloroform followed by hydrogen peroxide irrigation. Endo-Radar would not indicate a digital display at 24.5mm - at same length Neo-Sono-D indicated "0.0" - radiograph with instrument at 24.5mm.



FIGURE 10.15

Case 14, Clinical study (Investigation B): Tooth 22: previously paste-filled, hydrogen peroxide used as irrigant. Endo-Radar would not give a digital display. Neo-Sono-D indicated "0.0" at 22.5mm.



FIGURE 10.16

Case 24, Clinical study (Investigation B): Tooth 12: lateral resorptive defects present following luxation injury 9 years previously. Endo-Radar gave a "0.0" display at 17mm, whilst Neo-Sono-D fluctuated between 0.0-0.1 "long" at 18mm. Ledermix dressing has been previously placed in the canal. Hydrogen peroxide had been used prior to electronic length determination.



FIGURE 10.17

Case 31, Clinical study (Investigation B): Tooth 25: Partial pulpectomy carried out by previous operator. Endo-Radar, buccal canal indicated 1.2mm short, but in the palatal canal would not give a digital display when instrument reached a definite stop in the canal at 16mm. Neo-Sono-D, with same lengths as above, found to indicate 1.1-1.2mm short in the buccal canal, and 3.2mm short in the palatal canal.



FIGURE 10.18

Case 29, Clinical study (Investigation B): Tooth 36 associated with hypercementosis. The Neo-Sono-D was used alone in these canals. In the mesio-buccal canal the Neo-Sono-D indicated the instrument to be 2.2mm "short", in the mesio-lingual canal 2.0mm "short" and in the distal canal 1.4mm "short". Interestingly the instruments were found to be located almost at the former terminal of the canal before hypercementosis began.



FIGURE 10.19

Case 29, Clinical study (Investigation B): After 4 months the original intra-oral sinus tract had failed to resolve. Illustration to left shows result obtained with the Endo-Radar. Display indicated instrument to be at the "apex", but display was fluctuating at 21mm. Illustration to right shows result obtained with the Neo-Sono-D. This indicated the instrument to be 0.8mm beyond the foramen at 20.5mm. Neo-Sono-D took over 30 seconds to stabilize its digital display.

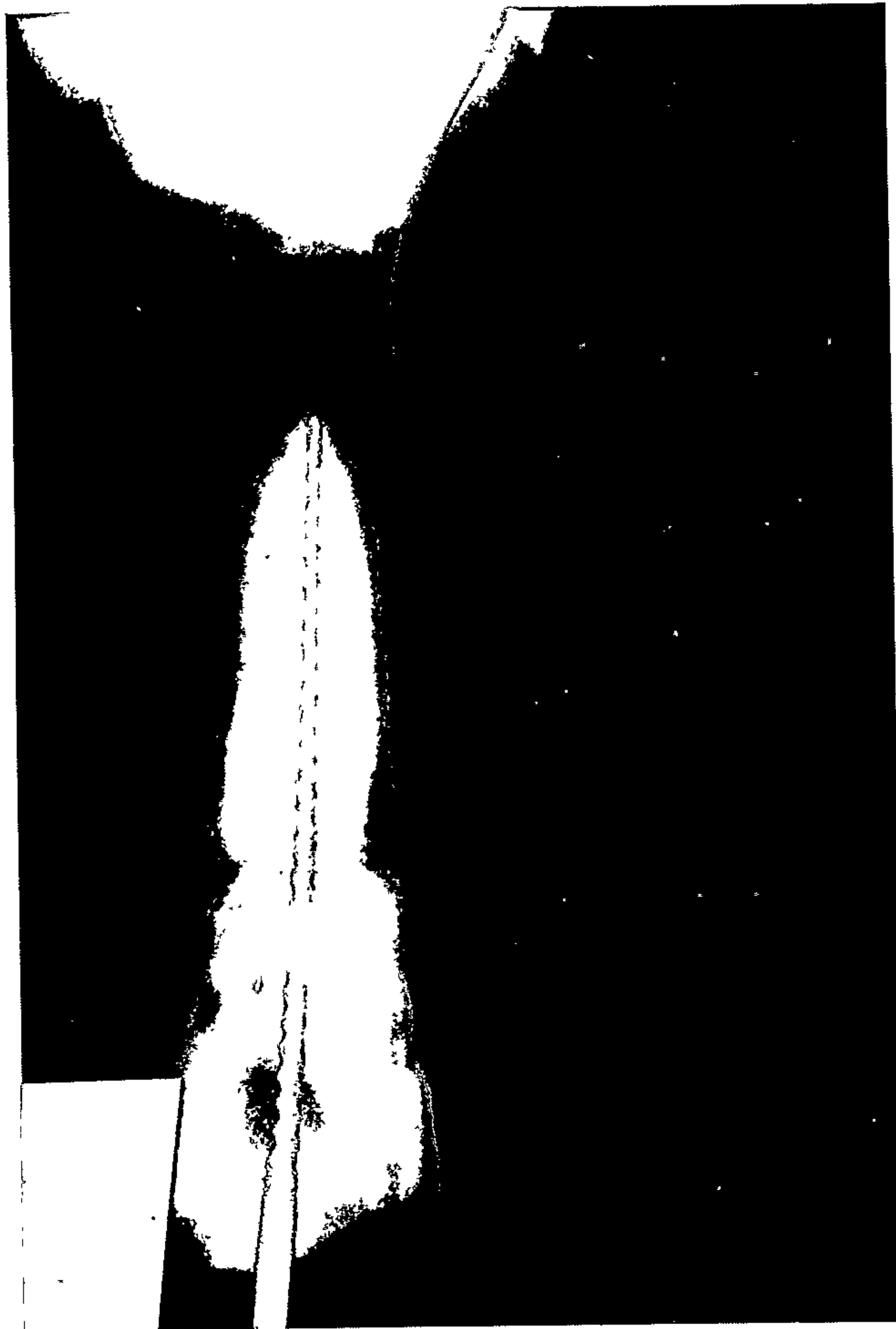


FIGURE 10.20

Case 35, Laboratory study (Investigation C): Tooth 22: Neo-Sono-D indicated instrument to be 0.1 to 0.2mm beyond the apex at 19.5mm. At same length Endo-Radar indicated the instrument to be 1.2mm short of the apex. Rotating the instrument with no vertical movement changed reading to "0.0".



FIGURE 10.21

Case 36, Laboratory study (Investigation C): Tooth 23: Neo-Sono-D indicated instrument to be 0.6 to 0.7mm short of the "apex" at 20mm. Display was fluctuating. The Endo-Radar at the same length read 1.6-1.7mm short of the "apex" without any fluctuation.



FIGURE 10.22

Case 24, Laboratory study (Investigation C): Tooth 16: Neo-Sono-D indicated mesio-buccal canal instrument to be 1.4mm "short" at 17.5mm disto-buccal canal instrument to be 0.6mm "short" at 19mm, and the palatal canal instrument to be 0.2 to 0.3mm "long" at 21mm. The display in the palatal canal was fluctuating. The Endo-Radar displays at the same instrument lengths were mesio-buccal, 0.8mm "short", disto-buccal 1.0mm "short" and palatal 0.4mm "long".



FIGURE 10.23

Case 6, Laboratory study (Investigation C): Tooth 23:

To left: Neo-Sono-D measurement. Instrument advanced down canal until Neo-Sono-D indicated foramen had been reached. At 18mm Neo-Sono-D indicated instrument to be fluctuating between 0.1mm "short" and at the apex. Display took some time to stabilize with display varying from 1.3mm "short" to 0.5mm "long". However, when Endo-Radar was used (to right) this device indicated the foramen reached at 18mm. Display stabilized at this length much more rapidly than occurred with the Neo-Sono-D.



FIGURE 10.24

Precalibration of the Endo-Radar in the gingival crevice of posterior teeth was complicated by limited access and infalling buccal mucosa.

TABLES

TABLE 1.1

DEVIATION BETWEEN ANATOMIC APEX AND APICAL FORAMEN

Researcher	No.of teeth examined	Type of teeth used	Per cent of roots showing deviations	Average deviation (in mm.)
Kuttler (1955)	402	not specified	68%	0.5
Green (1960)	700	maxillary and mandibular posterior teeth	50%	0.3
Chapman (1969)	120	maxillary and mandibular anterior teeth	Not stated	0.364 (max.) 0.346 (mand.)
Levy & Glatt (1970)	92	dissociated roots	66.4%	0.2
Burch & Hulen (1972)	877	maxillary and mandibular anterior and posterior teeth	92.4%	0.59
Dummer, McGinn & Rees (1984)	270	maxillary and mandibular anterior and premolar teeth	Not stated	0.38

TABLE 1.2

AVERAGE TOOTH LENGTHS IN MILLIMETRES

Sample Size		Maxillary					Mandibular								
		Central Incisor	Lateral Incisor	Canine	First Premolar	Second Premolar	First Molar	Second Molar	Central Incisor	Lateral Incisor	Canine	First Premolar	Second Premolar	First Molar	Second Molar
Bjorndal et al (1975)	?	23.7	23.1	27.3	22.3	22.3	22.3	22.2	21.8	23.3	26.0	22.9	22.3	22.0	21.7
Weine (1983)	9000	23.0	22.5	27.0	21.0	21.0	20.3	20.0	21.0	21.0	24.0	21.5	22.0	21.0	20.0
Grossman (1981)	?	23.0	22.0	26.5	20.5	21.5	20.5	20.0	20.5	21.0	25.5	20.5	22.0	21.0	20.0
Cohen & Burns (1984)	?	22.5	22.0	26.5	20.6	21.5	20.8	20.0	20.7	21.1	25.6	21.6	22.3	21.0	19.8
Nicholls (1984)	?	21.0	20.5	25.0	19.0	20.0	-	-	19.0	19.5	24.0	20.0	21.0	-	-
Kraus et al (1969)	?	23.5	22.0	27.0	23.5	22.5	19.5	18.0	21.5	23.5	26.0	22.5	22.5	21.5	20.0
Gabrial + (1965)	?	22.5	22.0	26.5	20.6	21.5	20.8	20.0	20.7	21.1	25.6	21.6	22.3	21.0	19.8

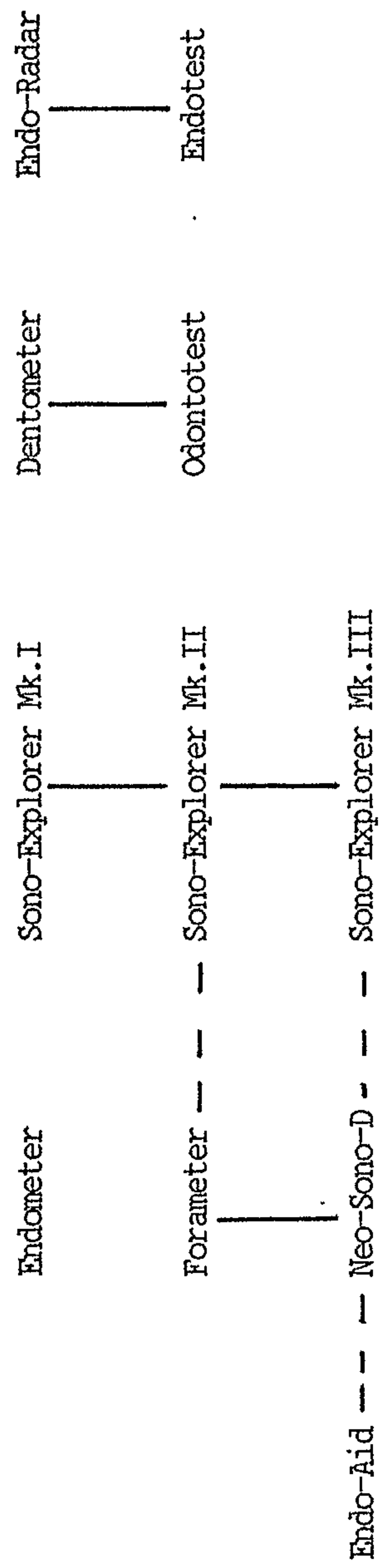
? Not stated

* Modified for Black G.V.: Descriptive anatomy of the human teeth ed.4. Philadelphia, 1897.

+ From Black G.V.: Descriptive anatomy of the human teeth ed.5. Philadelphia, 1904.

TABLE 6.1

DEVELOPMENT OF SOME COMMERCIALY AVAILABLE ELECTRONIC APEX LOCATORS



Legend: ——— direct development
 - - - - - parallel development

TABLE 8.1

DISTRIBUTION OF TEETH - INVESTIGATION A, ANATOMIC;
INVESTIGATION B, CLINICAL; AND INVESTIGATION C, AGAR STUDIES

Investigation	Arch	Anteriors	Premolars	Molars	Total Teeth	Total Canals
A Anatomic Study	Maxilla	17*	4	4	35	45
	Mandible	5*	4*	1*		
B Clinical Study	Maxilla	20	3	4	39	64
	Mandible	3	-	9		
C Laboratory Study	Maxilla	11	5	2	41	67
	Mandible	7	9	7		
TOTALS:		63	25	27	115	176

Notes:

- * additional tooth this category not included in total due to root fracture or extraction.

TABLE 9.1

ANATOMIC STUDY (INVESTIGATION A)
CANAL CONTENTS AND LENGTH DETERMINATION

CANALS CONTAINING VITAL PULP TISSUE - SUCCESSFUL READINGS - ENDO-RADAR

Total successful* readings	Total long readings	Distance beyond foramen (millimetres)	Total short readings	Distance from foramen (millimetres)	Total readings at foramen
24	12	0.01 - 0.49	4	0.01 - 0.49	1
		0.5 - 0.99	1	0.5 - 0.99	1
		1.0 - 1.49	3	1.0 - 1.49	2
		1.5 - 1.99	2	1.5 - 1.99	1
		2.0	2	2.0	6

* unsuccessful readings: due to periodontal disease (5); other causes (2)

CANALS CONTAINING VITAL PULP TISSUE - SUCCESSFUL READINGS - NEO-SONO-D

Total successful* readings	Total long readings	Distance beyond foramen (millimetres)	Total short readings	Distance from foramen (millimetres)	Total readings at foramen
79	10	0.01 - 0.49	7	0.01 - 0.49	2
		0.5 - 0.99	1	0.5 - 0.99	1
		1.0 - 1.49	1	1.0 - 1.49	3
		1.5 - 1.99	1	1.5 - 1.99	3
		2.0	0	2.0	10

* unsuccessful readings: due to unknown causes (1)

: due to root fracture preventing reading comparison (3)

TABLE 9.2

ANATOMIC STUDY (INVESTIGATION A)
CANAL CONTENTS AND LENGTH DETERMINATION
CANALS CONTAINING NON-VITAL PULP TISSUE - SUCCESSFUL READINGS - ENDO-RADAR

Total successful* readings	Total long readings	Distance beyond foramen (millimetres)	Total short readings	Distance from foramen (millimetres)	Total readings at foramen
10	6	0.01 - 0.49	1	0.01 - 0.49	2
		0.5 - 0.99	2	0.5 - 0.99	0
		1.0 - 1.49	0	1.0 - 1.49	0
		1.5 - 1.99	3	1.5 - 1.99	0
		2.0	0	2.0	1

* unsuccessful readings: due to periodontal disease (5); other causes (2)

CANALS CONTAINING NON-VITAL PULP TISSUE - SUCCESSFUL READINGS - NEO-SONO-D

Total successful* readings	Total long readings	Distance beyond foramen (millimetres)	Total short readings	Distance from foramen (millimetres)	Total readings at foramen
15	7	0.01 - 0.49	1	0.01 - 0.49	0
		0.5 - 0.99	4	0.5 - 0.99	3
		1.0 - 1.49	1	1.0 - 1.49	0
		1.5 - 1.99	1	1.5 - 1.99	0
		2.0	0	2.0	3

* unsuccessful readings: nil

TABLE 9.3

ANATOMIC STUDY (INVESTIGATION A)
CANALS CONTAINING VITAL PULP TISSUE

Digital display and radiographic instrument position - Endo-Radar (E_1)

Display	Number	Difference between electronic and actual lengths (E_1-A)*	Number
Indicating foramen	16	nil difference	1
Fluctuating display	0		
Indicating short	6	negative difference	11
Indicating long	2	positive difference	12
Unsuccessful**	6	Unsuccessful measurements	0
Total	24	Total	24

** Not used (periodontal involvement): 5
Mean difference: 0.70 millimetre + 2.28
No reading: 1

Digital display and radiographic instrument position - Neo-Sono-D (E_2)

Display	Number	Difference between electronic and actual lengths (E_2-A)*	Number
Indicating foramen	13	nil difference	0
Fluctuating foramen	7		
Indicating short	2	negative difference	19
Fluctuating short	3		
Indicating long	6	positive difference	10
Fluctuating long	3		
Unsuccessful**	1	Unsuccessful measurements***	3
Total	35	Total	32

** No reading: 1
Mean difference: 1.89 millimetre + 2.84
*** No reading: 1
No measurements possible due to root fracture: 2

* NOTE: E_1 - length as measured by Endo-Radar
 E_2 - length as measured by Neo-Sono-D
A - length as measured directly with file and apical extent verified visually

TABLE 9.4

ANATOMIC STUDY (INVESTIGATION A)
CANALS CONTAINING NON-VITAL PULP TISSUE

Digital display and radiographic instrument position - Endo-Radar (E₁)

Display	Number	Difference between electronic and actual lengths (E ₁ -A)*	Number
Indicating foramen	8	nil difference	1
Fluctuating	0		
Indicating short	2	negative difference	3
Indicating long	0	positive difference	6
Unsuccessful	5*	Unsuccessful measurements*	5
Total	15	Total	15

** Not used (periodontal involvement): 1
No reading: 4
Mean difference: 0.06 millimetre + 2.07

Digital display and radiographic instrument position - Neo-Sono-D (E₂)

Display	Number	Difference between electronic and actual lengths (E ₂ -A)*	Number
Indicating foramen	8		
Fluctuating foramen	3	nil difference	3
Indicating short	3		
Fluctuating short	1	negative difference	6
Indicating long	0		
Fluctuating long	0	positive difference	7
Unsuccessful	0	Unsuccessful measurements	0
Total	15	Total	15

Mean difference: 0.8 millimetre + 2.56

* NOTE: E₁ - length as measured by Endo-Radar
E₂ - length as measured by Neo-Sono-D
A - length as measured directly with file and apical
extent verified visually

TABLE 9.5

ANATOMIC STUDY (INVESTIGATION A)

COMPARISON OF ACTUAL AND INDICATED LENGTHS AS DETERMINED BY THE
ENDO-RADAR AND NEO-SONO-D (ALL CANALS)

Device	N	Mean indicated length (millimetres)	Mean actual length (millimetres)	Mean difference between actual and indicated lengths (millimetres)	Range	Standard deviation
Endo-Radar	35	21.17	21.78	± 0.48	14.5- 31.0	± 2.25
Neo-Sono-D	48	20.63	21.78	± 1.48	14.0- 31.0	± 2.78

This data derived from complete data presented in Table A.2 of Appendix A.

TABLE 9.6

ANATOMIC STUDY (INVESTIGATION A)

DIFFERENCE BETWEEN ELECTRONICALLY DETERMINED AND ACTUAL LENGTHS
(IN NUMBER OF MEASUREMENTS TAKEN)

	Endo-Radar	Neo-Sono-D	Endo-Radar	Neo-Sono-D	TOTALS			
Distance from foramen (millimetres)	"Long"	"Long"	"Short"	"Short"	Endo-Radar "long" "short"	Neo-Sono-D "long" "short"		
0.0 (.0-.49)	5	9	3	1	5	3	9	1
0.5 (.5-.99)	3	5	1	4	3	1	5	4
1.0 (1.0-1.49)	2	2	2	3	2	2	2	3
1.5 (1.5-1.99)	8	2	1	4	5	1	2	4
2.0 (2.0-2.49)	3	0	1	2	3	1	-	2
Greater than 2.5	0	0	6	11	-	6	-	11
TOTAL:	18	18	14	25	18	14	18	25

Notes: (1) Endo-Radar at foramen in 2 cases

(2) Neo-Sono-D at foramen in 2 cases

(3) Endo-Radar - wouldn't read - 5 cases

- not used due to periodontal disease - 5 cases

- not used - 1 case

(4) Neo-Sono-D - wouldn't read - 1 case

- comparison unable to be measured in 2 cases due to fractured roots

TABLE 9.7
ANATOMIC STUDY (INVESTIGATION A)
SUMMARY OF ACTUAL AND CORRECTED CANAL LENGTHS

Device	Total readings	Total corrected readings	Mean of difference between actual and electronic lengths $\pm$ standard deviations (millimetres)	Mean of difference between actual and corrected electronic lengths ($\pm$ standard deviations (millimetres))
Endo-Radar	33	10	- 0.5 $\pm$ 2.28	- 0.07 $\pm$ 2.31
Neo-Sono-D	44	19	- 1.5 $\pm$ 2.79	- 2.44 $\pm$ 3.40

This data derived from complete data presented in Tables A.2 and A.3 of Appendix A.

TABLE 9.8

ANATOMIC STUDY (INVESTIGATION A)

DIFFERENCE BETWEEN CORRECTED LENGTH AND ACTUAL LENGTH
(LENGTH MEASUREMENTS TAKEN)

Endo-Radar		Neo-Sono-D	Endo-Radar	Neo-Sono-D	TOTALS		
Distance (millimetres)	"Long"	"Long"	"Short"	"Short"	Endo-Radar "long" "short"	Neo-Sono-D "long" "short"	
0.0 (.0-.49)	3	7	0	0	3	0	6 0
0.5 (.5-.99)	1	4	0	1	1	0	5 0
1.0 (1.0-1.49)	0	4	2	3	0	2	6 3
1.5 (1.5-1.99)	3	0	0	2	3	0	1 2
2.0 (2.0-2.49)	1	1	0	1	1	0	0 1
Greater than 2.5	2	0	2	9	2	2	0 9
TOTAL:	10	16	4	16	10	4	16 16

Note: at foramen: Endo-Radar : 0
: Neo-Sono-D : 0

TABLE 9.9

ANATOMIC STUDY (INVESTIGATION A)

RADIOGRAPHIC SURVEY AVAILABLE FOR INTERPRETATION

Orthopantomogram*	Periapical**	No radiographs	Total cases	Total teeth
13	17	1	31	37

* per case

** per tooth

TABLE 9.10

ANATOMIC STUDY (INVESTIGATION A)

EFFECT OF PERIAPICAL STATE ON ACCURACY OF READINGS - CANALS
 ASSESSED AS ASSOCIATED WITH RADIOGRAPHIC PERIAPICAL CHANGE

Distance from foramen (millimetres)	Slight periapical change				Moderate periapical change				Severe periapical change			
	Endo-Radar Neo-Sono-D indicating		Endo-Radar Neo-Sono-D indicating		Endo-Radar Neo-Sono-D indicating		Endo-Radar Neo-Sono-D indicating		Endo-Radar Neo-Sono-D indicating		Endo-Radar Neo-Sono-D indicating	
	Long	Short	Long	Short	Long	Short	Long	Short	Long	Short	Long	Short
at foramen	0	0	0	0	0	0	0	1	0	0	0	0
0.01 - 0.49	0	2	4	1	1	0	0	0	0	1	0	0
0.5 - 0.99	2	1	2	1	0	0	0	2	1	0	1	0
1.0 - 1.49	2	0	0	1	0	0	0	0	0	0	1	0
1.5 - 1.99	2	1	0	2	0	0	0	0	1	0	0	0
> 2.0	0	2	0	6	0	1	0	2	0	0	0	1
TOTALS:	6	6	6	11	1	1	2	4	1	1	2	1

Notes: (1) Endo-Radar: failures to read
 slight periapical change : 4 canals
 moderate periapical change : 4 canals
 severe periapical change : 1 canal
 (2) Neo-Sono-D : one canal two readings taken

TABLE 9.11

ANATOMIC STUDY (INVESTIGATION A)

EFFECT OF PERIAPICAL STATE ON ACCURACY OF READINGS -
CANALS ASSESSED AS ASSOCIATED WITH NO PERIAPICAL CHANGE
OR INTERMINABLE OR UNKNOWN PERIAPICAL CHANGE

Distance from foramen (millimetres)	No periapical change				Indeterminable/unknown periapical change			
	Endo-Radar		Neo-Sono-D		Endo-Radar		Neo-Sono-D	
	Long	Short	Long	Short	Long	Short	Long	Short
at foramen	0	1	0	0	0	1	0	1
0.01 - 0.49	2	0	3	0	1	0	1	1
0.5 - 0.99	1	0	2	1	0	0	0	0
1.0 - 1.49	0	0	1	1	1	2	0	1
1.5 - 1.99	2	0	1	0	0	0	0	1
> 2.0	2	3	0	4	0	0	0	0
TOTALS*	7	4	7	6	2	2	1	3

* readings at foramen no included in total

- Notes: (1) Endo-Radar: failures to read
no periapical change: 1 canal
(2) Endo-Radar: no reading due to root fracture
: indeterminable/unknown periapical change: 2 canals
(3) Neo-Sono-D: no reading due to root fracture
: indeterminable/unknown periapical change: 2 canals

TABLE 9.12

ANATOMIC STUDY (INVESTIGATION A)

PERIAPICAL STATE AND ACCURACY OF READINGS
(ENDO-RADAR AND NEO-SONO-D)

Periapical state	N	instrument position*					
		Endo-Radar			Neo-Sono-D		
		Long	Short	at foramen	Long	Short	at foramen
No PA change	13	7	4	1	7	6	0
Unknown/un- determinable	7	2	2	1	1	3	1
Slight change	16	6	6	0	6	11	0
Moderate change	6**	1	1	0	2	4	1
Severe change	3	1	1	0	2	1	0

Note: * when compared to directly measured canal length
 ** includes one canal assessed as having questionable periapical
 change

TABLE 9.13

CLINICAL STUDY (INVESTIGATION B)

CANAL STATES AND DEVICE DISTRIBUTION OF MEASUREMENTS WITH ENDO-RADAR AND NEO-SONO-D

Measurements taken with:	Non		Previously		Previously	
	Vital	Vital	Extirpated	Debrided	Root Filled	Paste Filled
						Unknown
Neo-Sono-D	16	7	13	8	8	3
No reading	0	0	1	0	0	0
Endo-Radar	9	4	4	2	4	1
No reading	3	2	5	6	2*	2
Not used (due to periodontal disease)	4	1	3	-	2	-
TOTAL NUMBER OF CANALS	16	7	11	8	7	3

Notes: * 1 canal with calcium hydroxide, 1 canal with "Ledermix"

TABLE 9.14

CLINICAL STUDY (INVESTIGATION B)

MEASUREMENTS TAKEN WITH ENDO-RADAR AND NEO-SONO-D GROUPED BY PERIAPICAL STATE

Periapical State	Vital	Non Vital	Extirpated	Debrided	Previously Root filled	Previously Paste filled	Unknown
PA change	3	6	10	6	5	3	-
No PA change	13	0	1	0	0	0	1
Questionable change	0	0	0	2	0	0	0
Open Apex	0	0	0	0	1	0	0
TOTAL NUMBER OF CANALS	16	6	11	8	6	3	1

TABLE 9.15

CLINICAL STUDY (INVESTIGATION B)

DISTANCE BETWEEN RADIOGRAPHIC APEX AND/OR CANAL TERMINATION
AND THE INSTRUMENT TIP AT TIME OF READING

	Endo-Radar	Total	Neo-Sono-D	Total
Beyond Radio- graphic apex (millimetres)				
0.01-0.49	1		1	
0.5-0.99	6		5	
1.0-1.49	5	14	4	14
1.5-1.99	0		2	
2.0-2.49	1		2	
> 2.5	1		0	
At radiographic apex/canal termination	2	2	8	8
Short of radio- graphic apex				
0.01-0.49	0		2	
0.5-0.99	4		6	
1.0-1.49	6	20	15	43
1.5-1.99	3		7	
2.0-2.49	2		0	
> 2.5	5		13	
No reading	0	9	0	2
TOTALS		45		67

TABLE 9.16

CLINICAL STUDY (INVESTIGATION B)

ELECTRONIC MEASUREMENTS AND PERIAPICAL HEALTH
CANALS ASSOCIATED RADIOGRAPHICALLY WITH PERIAPICAL BREAKDOWN

	Short of radiographic apex		Beyond radiographic apex	
Radiographic instrument position	Endo-Radar	Neo-Sono-D	Endo-Radar	Neo-Sono-D
at foramen	0	0	0	7*
0.1-0.49	0	1	1	1
0.50-0.99	2	4	3	3
1.0-1.49	2	8	4	1
1.5-1.99	1	2	0	2
2% greater	2	6	2	2
TOTALS	7	21	10	9

* 3 canals associated with hypercementosis

TABLE 9.17

CLINICAL STUDY (INVESTIGATION B)

ELECTRONIC MEASUREMENTS AND PERIAPICAL HEALTH

CANALS NOT ASSOCIATED RADIOGRAPHICALLY WITH PERICAPICAL LESIONS

	Short of radiographic apex		Beyond radiographic apex	
Radiographic instrument position	Endo-Radar	Neo-Sono-D	Endo-Radar	Neo-Sono-D
at foramen	2	1	0	0
0.1-0.49	0	1	0	0
0.50-0.99	2*	2	3	2
1.0-1.49	4	7*	1	3
1.5-1.99	2	5*	0	0
2% greater	5	7	0	0
TOTALS	13	22	4	5

* 1 canal in each group associated with questionable periapical lesion

NB: 3 canals couldn't be measured

TABLE 9.18

CLINICAL STUDY (INVESTIGATION B)

FREQUENCY OF DIGITAL DISPLAY OCCURRING WITH THE
ENDO-RADAR AND NEO-SONO-D

Device	Short Display	Foramen Display	Long Display	Fluctuating Display	Failures to read	Total number of displays
Endo-Radar	9	18	2	2	3	34
Neo-Sono-D	24	15	10	18	0	67

TABLE 9.19

CLINICAL STUDY (INVESTIGATION B)

MEAN DIGITAL DISPLAY AND CORRESPONDING MEAN RADIOGRAPHIC
INSTRUMENT POSITION AS DETERMINED WITH THE ENDO-RADAR

Mean Digital Display	Mean Radiographic Instrument position (millimetres)
- 0.52 ± 0.84	- 0.62 ± 1.64

TABLE 9.20

CLINICAL STUDY (INVESTIGATION B)

CANAL CONTENTS AND PERIAPICAL STATES OF CANALS
WHOSE WORKING LENGTH IS DETERMINED WITH THE ENDO-RADAR

Canal state*				Periapical state*						
V	NV	EXT	DEB	PREV RF	PREV PF	U	PA	No PA	quest	U ¹
9	4	4	2	4	1	1	34	15	2	1

* LEGEND: V - vital
NV - non vital
EXT - extirpated
DEB - debrided
PREV RF - previously root filled
PREV PF - previously paste filled
U - unknown
PA - radiographic evidence of periapical breakdown
no PA - no radiographic evidence of periapical breakdown
quest - questionable radiographic evidence of periapical
breakdown
U - unknown radiographic evidence of periapical
breakdown
U¹ - unknown radiographic evidence of periapical
breakdown

TABLE 9.21

CLINICAL STUDY (INVESTIGATION B)

CANAL CONTENTS AND PERIAPICAL STATES OF CANALS
WHOSE WORKING LENGTH IS DETERMINED WITH THE NEO-SONO-D

Canal state*					Periapical state*					
V	NV	EXT	DEB	PREV RF	PREV PF	U	PA	No PA	quest	U ¹
16	7	13	8	8	2	1	34	15	2	1

* LEGEND: V - vital
 NV - non vital
 EXT - extirpated
 DEB - debrided
 PREV RF - previously root filled
 PREV PF - previously paste filled
 U - unknown
 PA - radiographic evidence of periapical breakdown
 no PA - no radiographic evidence of periapical breakdown
 quest - questionable radiographic evidence of periapical breakdown
 U - unknown radiographic evidence of periapical breakdown
 U¹ - unknown radiographic evidence of periapical breakdown

TABLE 9.22

CLINICAL STUDY (INVESTIGATION B)

MEAN DIGITAL DISPLAY AND CORRESPONDING MEAN RADIOGRAPHIC
INSTRUMENT POSITION AS DETERMINED WITH THE NEO-SONO-D

Mean Digital Display (+ standard deviation)	Mean Radiographic Instrument position (+ standard deviation) (millimetres)
- 0.47 ± 1.10	- 0.06 ± 1.02

TABLE 9.23

CLINICAL STUDY (INVESTIGATION B)

DISTRIBUTION OF DIGITAL DISPLAY AND INSTRUMENT POSITION RELATED
TO PERIAPICAL STATE FOR CANALS MEASURED WITH THE ENDO-RADAR

ENDO-RADAR

	No. of readings	Digital display		No reading		Instrument position			No reading
		Short	0.0	Long	3*	5	8	4**	
Periapical change	21*	2	11		3*	5	8	4**	0
Questionable periapical change	1	1	0	0	0	0	0	0	1
No periapical change	15	7	7	0	0	1	11	2	1
Open apex	1***	0	0	0	0	1	0	0	0

* Two readings taken in two canals

** Very large variation in display in one canal (1.2 to 0.1 "long")
three of this total "no readings" found to be at foramen after

*** Subsequent measurement with Neo-Sono-D

+ Found to be long after length determination with Neo-Sono-D

TABLE 9.24

CLINICAL STUDY (INVESTIGATION B)

DISTRIBUTION OF DIGITAL DISPLAY AND INSTRUMENT POSITION RELATED
TO PERIAPICAL STATE FOR CANALS MEASURED WITH THE NEO-SONO-D

NEO-SONO-D

	No. of readings	Digital display		No reading	Instrument position			No reading	
		Short	0.0 Long		Short	Apex	Long		
Periapical change	43*	14	11	7*	11*	26+	8	10	1
Questionable periapical change	2**	2	0	1	0	2	0	0	0
No periapical change	17	5	3	5	5	15	1	1	0
Open apex	1*	0	0	0	1	1	0	0	0

* canal with open apex associated with periapical area

** 1 canal measured twice

*** 1 canal measured three times

+ 2 canals measured twice

TABLE 9.25

LABORATORY STUDY (INVESTIGATION C)

MEAN DIGITAL DISPLAY, RADIOGRAPHIC INSTRUMENT POSITION AND MEASUREMENT
DIFFERENCE FOR THE ENDO-RADAR AND NEO-SONO-D

Mean Digital Display (+ standard deviation) Endo-Radar Neo-Sono-D	Mean Radiographic Instrument position (+ standard deviation)	Mean Measurement difference (+ standard deviation) Endo-Radar Neo-Sono-D
-0.09+0.70	-0.14+0.53	-0.14+0.73 -0.12+0.77

This table derived from complete data presented in Table C.1 of Appendix C

TABLE 9.26

LABORATORY STUDY (INVESTIGATION C)

SUMMARY OF FILE PLACEMENT METHOD RESULTS

				Difference between lengths obtained with Endo-Radar (E ₁) Neo-Sono-D (E ₂) and radiographic (R) lengths		
File Placement method code (see below)	No. of canals measured		Digital Display (mean ± standard deviation)	Radiographic Instrument position (mean ± standard deviation)	E ₁ -R (mean ± standard deviation)	E ₂ -R (mean ± standard deviation)
	ER	NSD				
AX	6 ¹	8	-0.12±0.91	-0.18±1.14	-0.07±0.94	-0.30±1.14
AY	20	21 ²	0	-0.03±0.16	0.16±0.33	-0.03±0.30
Bx	32 ³	34	-0.05±0.91	0.06±1.32	-0.36±0.54	-0.45±1.14
By*	1	1	—	—	—	—

* only one canal

NOTE A: Separate measurements taken with Endo-Radar and Neo-Sono-D

B: File not moved between taking of Endo-Radar and Neo-Sono-D measurements

x: File inserted until visible at foramen

y: File inserted until device indicated foramen had been reached

1. 2 canals discounted - 1 no reading; 1 reading unable to be used

2. 2 measurements made in the one canal due to difficulty in stabilizing digital readout

3. Endo-Radar would not register a reading in 2 canals

TABLE 9.27

LABORATORY INVESTIGATION (INVESTIGATION C)
DIGITAL DISPLAY - SUMMARY

Device	No. of displays	Zero displays	Non-fluctuating displays	Short (Non-fluctuating) display	Long (Non-fluctuating) display	Fluctuating display	No readings
Endo-Radar	59	30	50	16	14	6	3
Neo-Sono-D	65	11	31	10	10	31	0

TABLE 9.28

LABORATORY INVESTIGATION (INVESTIGATION C)

DISTRIBUTION OF FLUCTUATING DISPLAYS - BY DEVICE AND INSTRUMENT PLACEMENTS

Device	Instrument placement method	Indicating short of foramen	Indicating beyond the foramen	Indicating at, and short of foramen	Indicating at, and beyond foramen	Indicating at foramen and short and beyond foramen	Indicating short of and beyond foramen	Totals
Endo-Radar	Ay	0	0	0	0	0	0	0
	Ax	1	0	0	0	0	0	1
	Bx	3	0	1	1	0	0	5
Neo-Sono-D	Ay	2	0	4	4	2	0	12
	Ax	3	1	0	0	1	1	6
	Bx	6	5	1	2	0	0	14
TOTALS:								
Endo-Radar		4	0	1	1	0	0	6
Neo-Sono-D		11	6	5	6	3	1	32

NOTE A: Separate measurements taken with Endo-Radar and Neo-Sono-D
 B: File not moved between taking of Endo-Radar and Neo-Sono-D measurements
 x: File inserted until visible at foramen
 y: File inserted until device indicated foramen had been reached

TABLE 9.29

COMPARISON OF RESULTS OF ANATOMIC STUDY (INVESTIGATION A)
 TESTING FOR THE SIGNIFICANCE OF THE DIFFERENCES OF THE
 MEANS OF THE MEASURED DISTANCES (ENDO-RADAR VS NEO-SONO-D)

Groups tested	Significance
All canals	ns
Vital canal contents	ns
Non-vital canal contents	ns
Periapical destruction	ns
No periapical destruction	ns

CODE: not significant ns p 0.1
 slightly significant + 0.1 p 0.05
 significant ++ 0.05 p 0.01
 very significant +++ 0.01 p 0.001
 highly significant ++++ 0.001 p.

TABLE 9.30

COMPARISON OF RESULTS OF ANATOMIC STUDY (INVESTIGATION A)
 TESTING FOR THE SIGNIFICANCE OF THE DIFFERENCES OF THE
 MEANS OF THE MEASURED DISTANCES OBTAINED WITH THE
 ENDO-RADAR AND NEO-SONO-D UNDER CERTAIN CONDITIONS

Endo-Radar		Neo-Sono-D	
Groups Tested	Significance	Groups Tested	Significance
vital vs non-vital canal contents	ns	vital vs non-vital	ns
Periapical destruction vs No periapical destruction	ns	Periapical destruction vs No periapical destruction	ns

CODE: not significant ns p 0.1
 slightly significant + 0.1 p.0.05
 significant ++ 0.05 p.0.01
 very significant +++ 0.01 p.0.001
 highly significant ++++ 0.001 p.

TABLE 9.31

COMPARISON OF RESULTS OF ANATOMIC STUDY (INVESTIGATION A)
TESTING FOR THE SIGNIFICANCE OF THE DIFFERENCES OF THE
MEANS OF THE MEASURED DISTANCES MEASURED WITH THE
ENDO-RADAR AND NEO-SONO-D WHERE LENGTH CORRECTIONS HAVE
BEEN APPLIED

Groups tested	Significance
Endo-Radar vs Neo-Sono-D	ns
Endo-Radar corrected vs uncorrected	ns
Neo-Sono-D corrected vs uncorrected	ns

CODE: not significant ns p.0.1
 slightly significant + 0.1 p.0.05
 significant ++ 0.05 p.0.01
 very significant +++ 0.01 p.0.001
 highly significant ++++ 0.001 p.

TABLE 9.32

COMPARISON OF RESULTS OF CLINICAL STUDY (INVESTIGATION B)

TESTING FOR THE SIGNIFICANCE OF THE DIFFERENCES OF THE

MEANS OF THE MEASURED DISTANCES (ENDO-RADAR VS NEO-SONO-D)

Groups tested	Significance
All canals	ns
Vital canal contents	ns
Non-vital canal contents	ns
Periapical destruction	ns
No periapical destruction	ns

CODE: not significant ns p 0.1

 slightly significant .+ 0.1 p 0.05

 significant ++ 0.05 p 0.01

 very significant +++ 0.01 p 0.001

 highly significant ++++ 0.001 p.

TABLE 9.33

COMPARISON OF RESULTS OF CLINICAL STUDY (INVESTIGATION B)
 TESTING FOR THE SIGNIFICANCE OF THE DIFFERENCES OF THE
 MEANS OF THE MEASURED DISTANCES OBTAINED WITH THE
 ENDO-RADAR AND NEO-SONO-D UNDER CERTAIN CONDITIONS

Endo-Radar		Neo-Sono-D	
Groups Tested	Significance	Groups Tested	Significance
vital vs non-vital canal contents	ns	vital vs non-vital	ns
Periapical destruction vs No periapical destruction	ns	Periapical destruction vs No periapical destruction	ns

CODE: not significant ns p 0.1
 slightly significant + 0.1 p.0.05
 significant ++ 0.05 p.0.01
 very significant +++ 0.01 p.0.001
 highly significant ++++ 0.001 p.

TABLE 9.34

COMPARISON OF RESULT OF LABORATORY STUDY (INVESTIGATION C)
 TESTING FOR THE SIGNIFICANCE OF THE DIFFERENCES OF THE
 MEANS OF THE MEASURED DISTANCES (ENDO-RADAR VS NEO-SONO-D)

Groups tested	Significance
All canals	ns

CODE: not significant ns p.0.1
 slightly significant + 0.1 p.0.05
 significant ++ 0.05 p.0.01
 very significant +++ 0.01 p.0.001
 highly significant ++++ 0.001 p.

TABLE 9.35

COMPARISON OF RESULTS OF LABORATORY STUDY (INVESTIGATION C)
TESTING FOR THE SIGNIFICANCE OF DIFFERENCES OF THE MEANS
OF THE MEASURED DISTANCES FOR THE VARIOUS METHODS
INSTRUMENT PLACEMENTS (ENDO-RADAR VS NEO-SONO-D)

Groups tested	Significance
"Ay"*	+
"Ax"*	ns
"Bx"*	ns

NOTE: * "Ay": Separate measurements taken for Endo-Radar and
Neo-Sono-D
: file inserted until device indicated foramen
had been reached

"Ax": Separate measurements taken for Endo-Radar and
Neo-Sono-D
: file inserted until visible at apex

"Bx": File not moved between taking of readings with
Endo-Radar and Neo-Sono-D
: file inserted until visible at apex

CODE: not significant ns p.0.1
 slightly significant + 0.1 p.0.05
 significant ++ 0.05 p.0.01
 very significant +++ 0.01 p.0.001
 highly significant ++++ 0.001 p.

TABLE 9.36

COMPARISON OF RESULTS OF LABORATORY STUDY (INVESTIGATION C)
TESTING FOR THE SIGNIFICANCE OF THE DIFFERENCES OF THE MEANS
OF THE MEASURED DISTANCES OBTAINED WITH THE ENDO-RADAR AND
NEO-SONO-D UNDER VARIOUS INSTRUMENT PLACEMENT PROCEDURES

Endo-Radar		Neo-Sono-D	
Groups tested	Significance	Groups tested	Significance
"Ay"* vs "Ax"	ns	"Ay"* vs "Ax"	ns
"Ax"* vs "Bx"	++	"Ax"* vs "Bx"	*
"Ax"* vs "Bx"	ns	"Ax"+ vs "Bx"	ns

NOTE: * "Ay": Separate measurements taken for Endo-Radar and Neo-Sono-D
file inserted until device indicated foramen had been reached

"Ax": Separate measurements taken for Endo-Radar and Neo-Sono-D
file inserted until visible at apex

"Bx": File not moved between taking of readings with Endo-Radar and Neo-Sono-D
file inserted until visible at apex

CODE: not significant ns p.0.1
 slightly significant + 0.1 p.0.05
 significant ++ 0.05 p.0.01
 very significant +++ 0.01 p.0.001
 highly significant ++++ 0.001 p.

TABLE 9.37

COMPARISON OF RESULTS OF LABORATORY STUDY (INVESTIGATION C)
 TESTING FOR THE SIGNIFICANCE OF THE DIFFERENCES OF THE MEANS
 OF THE MEASURED DISTANCES OBTAINED WITH THE ENDO-RADAR AND
 NEO-SONO-D UTILIZING DIFFERENT TOOTH STORAGE MEDIA

Groups tested	Significance
Tap water	ns
Formalin	ns

CODE: not significant ns p.0.1
 slightly significant + 0.1 p.0.05
 significant ++ 0.05 p.0.01
 very significant +++ 0.01 p.0.001
 highly significant ++++ 0.001 p.

TABLE 9.38

COMPARISON OF RESULTS OF LABORATORY STUDY (INVESTIGATION C)
TESTING FOR THE SIGNIFICANCE OF THE DIFFERENCES OF THE MEANS
OF THE MEASURED DISTANCES OBTAINED WITH THE ENDO-RADAR AND
NEO-SONO-D UTILIZING DIFFERENT TOOTH STORAGE MEDIA

Endo-Radar		Neo-Sono-D	
Groups tested	Significance	Groups tested	Significance
Tap water vs formalin	+	Tap water vs formalin	+

CODE: not significant ns p.0.1
 slightly significant + 0.1 p.0.05
 significant ++ 0.05 p.0.01
 very significant +++ 0.01 p.0.001
 highly significant ++++ 0.001 p.

APPENDICES

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APPENDIX A

ANATOMIC STUDY (INVESTIGATION A)

a.

APPENDIX A ANATOMIC STUDY (INVESTIGATION A)

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TABLE A.1

ANATOMIC INVESTIGATION (Investigation A)

PATIENT AND CANAL DETAILS OF CANALS MEASURED IN INVESTIGATION A

Case No	Age	Tooth	Canal	Instrument size	Precal. ER	Canal state	Canal contents
1	85	11	/	15K	1.3	non-vital	pulp tissue
3	28	13	/	10K	4	vital	hemorrhagic pulp tissue
3	28	12	/	10K	4	vital	hemorrhagic pulp tissue
3	28	11	/	15K	4.5	vital	
4	16	16	MB	15K	5	vital	hemorrhagic pulp tissue
			DB	15K			
			P	15K			
5	35	11	/	20K	3.9	vital	
		21	/	20K	3.9	vital	
6	50	31	/	10K	periodontal disease	non-vital	very little pulp tissue
7	25	16	MB	15K	4	non-vital	very little pulp tissue
			DB	15K			
			P	15K			
8	45	15	/	15K	4.5	vital	hemorrhagic pulp tissue
9	13	12	/	15K	4	non-vital	purulent material *
9	13	11	/	15K	3.9	non-vital	*
9	13	21	/		4.3	N/A	**
9	13	22	/		4	N/A	**

* tissue mass at apex noted after extraction

** discounted from study

TABLE A.1 (continued)

Case No	Age	Tooth	Canal	Instrument size	Precal. ER	Canal state	Canal contents
10	13	34	/	15K	5	vital	hemorrhagic pulp tissue
11	25	12	/	15K	4.2 - 4.3	vital	
12	23	14	/	10K	5	non-vital	little tissue present
13	22	47	MB	15K	4.2	vital	hemorrhagic pulp tissue
			MLI	15K		vital	
			D	15K		vital	
14	70	13	/	10K	4.2	non-vital	nil
15	40	43	/	10K	5.5	vital	tissue present
16	18	15	/	15K	5.2	vital	tissue present
17		17	MB	15K		vital	
			D	15K		vital	
18	32	11	/	15K	5	non-vital	Ledermix remnants
		12	/	15K	3.9		
19	49	13	/	15K	A	vital	pulp tissue present
19	49	14	/	15K		vital	
19	49	43	/	15K		vital	
20	20	21	/	15K	5	non-vital	very little tissue present - no hemorrhage
21	25	35	/	15K	5	vital	pulp tissue present
22	49	21	/	15K	A	vital	pulp tissue present

TABLE A.1 (continued)

Case No	Age	Tooth	Canal	Instrument size	Precal. ER	Canal state	Canal contents
22	49	23	/	15K	A	vital	
23	29	35	/	15K	4	non-vital	little tissue present
24	33	16	MB	20K	4.5	non-vital	Ledermix remnants in canal
			DB	25K			
			P	30K			
25	32	35	/	15K		non-vital	very little pulp tissue present
26	27	11	/	20K	5	non-vital	hemorrhagic pulp tissue
27	64	43	/	15K	4.8	non-vital	little tissue in canal
28	31	31	/	15K	4.8	non-vital	little tissue in canal
29	55	23	/	15K	4.5	vital	hemorrhagic pulp tissue
30	57	21	/	20K	4.8	non-vital	purulent material in canal
31 ^a	36	21	/	15K	5	vital	hemorrhagic pulp tissue
31 ^b	36	22	/	15K	4.4		

Legend: A: Endo-Radar not used due to periodontal involvement

TABLE A2

ANATOMIC STUDY (INVESTIGATION A)

DIFFERENCE BETWEEN INDICATED AND MEASURED LENGTHS,
DIGITAL DISPLAY AND ACTUAL LENGTH MEASUREMENTS
OF TEETH IN INVESTIGATION A - CANALS ASSESSED AS CONTAINING VITAL TISSUE

Case No	Tooth	Canal	Difference between electronically determined and actual length (mm)		Digital Display		Measured length after indication (mm)		Actual length (mm)	Corrected canal length (mm)	
			ER	NSD	ER	NSD	ER	NSD		ER	NSD
1	11	/	+2.3	-1.2	0.0	0.0	25.0	22.5	23.7		
3 ^a	13	/	0.0	+0.5	-0.5	0.0	22.5	23.0	22.5	23.0	
3 ^b	12	/	+2.0	B	-0.5	B	24.0	B	22.0	24.5	
3 ^c	11	/	+2.2	+1.2	0.0	0.0	24.0	23.0	21.8		
4	16	MB	-1.7*	-7.2	-0.4	+0.5	20.5	15.0	22.2	20.9	14.5
		DB	-5.2*	-5.7	0.0	+0.4	16.5	16.0	21.7		15.6
		P	-4.6	-9.6	0.0	+1.5	19.0	14.0	23.6		12.5
5 ^a	11	/	+1.4*	1.6	0.0	0.0	26.0	23.0	24.6		
5 ^b	21	/	+1.2*	-1.3	0.0	0.0-0.1	26.0	23.5	24.8		23.4
8	15	/	+1.8*	-1.8	-3.9	0.7-0.8	21.0	21.0	22.8	24.9	21.7 21.8
10	34	/	-6.1	-9.1	0.0	+0.2	18.0	15.0	24.1		14.8
11	12	/	+0.6*	+0.1	0.0	0.0	23.5	23.0	22.9		

TABLE A2 (continued)

Case No	Tooth	Canal	Difference between electronically determined and actual length (mm)		Digital Display		Measured length after indication (mm)		Actual length (mm)	Corrected canal length (mm)	
			ER	NSD	ER	NSD	ER	NSD		ER	NSD
13	47	MB	-1.2	-1.7	-1.6	(-0.1- (0.0 (-0.4- (-0.5 (-0.6	22.0	21.5	23.2	23.6 22.0	21.6
		MLI	C	C	-2.3	0.0	22.0	21.0	C		
		D	C	C	B	-0.5- -0.6	B	21.0	C		
15	43	/	+0.1	+0.1	0.0	0.0	18.2	18.2	18.1		
16	15	/	-1.3	-0.3	0.0	+0.9- +1.0	18.0	19.0	19.3		18.1 18.0
17	17	MB	-0.9*	-2.7	+0.3	+0.3- +0.4	19.3	17.5	20.2		17.1 17.2
		DB	-3.5*	-5.0	+0.2	+0.3- +0.4	17.0	15.5	20.5		15.2 15.1
		P	-2.7	-2.7	0.0	+0.5	18.0	18.0	20.7		17.5
19 ^a	13	/	A	-1.0	A	0.0	A	23.0	24.0		
19 ^b	14	/	A*	-2.5	A	0.0	A	20.0	22.5		
19 ^c	43	/	A**	-0.6	A	0.0	A	24.0	24.6		
21	35	/	-0.1*	-3.1	0.0	+1.5- 0.0	21.0	21.0	21.1		19.5
22 ^a	21	/	A*	+0.4	A	0.0- +0.1	A	23.0	22.6		22.9
22 ^b	23	/	A*	+0.4	A	0.0	A	24.5	24.1		
24	16	P	-2.3#	-2.3##	0.0	-3.0	20.0	20.0	22.3		23.0

TABLE A2 (continued)

Case No	Tooth	Canal	Difference between electronically determined and actual length (mm)		Digital Display		Measured length after indication (mm)		Actual length (mm)	Corrected canal length (mm)	
			ER	NSD	ER	NSD	ER	NSD		ER	NSD
29	23	/	+1.5	+1.5	-0.9- -1.0	-0.2- +0.2	31.0	31.0	29.5	32.0 31.2	30.8
31 ^a	21	/	+0.1	+0.4 -0.4	0.0	(0.0- (-0.1 (0.0	24.0	(24.0 ((23.5	23.9		24 1
31 ^b	22	/	+0.3	+0.3	0.0	(0.0- (-0.1 (0.0- (-0.1	(22.5 ((22.5	22.5	22.2		22.4 22.6

Legend:

- * slight periapical destruction
- ** moderate periapical destruction
- *** severe periapical destruction
- A Endo-Radar not used due to periodontal involvement
- B Endo-Radar would not indicate a digital display
- C Root fractured on removal: no measurement possible
- # initial measurement
- ## after some canal preparation

TABLE A3

ANATOMIC STUDY (INVESTIGATION A)

DIFFERENCE BETWEEN INDICATED AND MEASURED LENGTHS,
DIGITAL DISPLAY AND ACTUAL LENGTH MEASUREMENTS
OF TEETH IN INVESTIGATION A - CANALS ASSESSED AS CONTAINING NON-VITAL TISSUE

Case No	Tooth	Canal	Difference between electronically determined and actual length (mm)		Digital Display		Measured length after indication (mm)		Actual length (mm)	Corrected canal length (mm)	
			ER	NSD	ER	NSD	ER	NSD		ER	NSD
6*	31	/	A	+0.3	A	0.0- -0.1	A	22.0	21.7		22.1
7*	16	MB	-0.1	-0.6	0.0	0.0	20.5	20.0	20.6		
		DB	+0.8	+1.7	0.0	0.0	20.1	21.0	19.3		
		P	+0.5	-0.5	0.0	0.0	22.0	21.0	21.5	18.9	
9a**	12	/	-5.8	-6.8	-0.9	0.0	18.0	17.0	23.8		
9b**	11	/	B	-7.1	B	0.0	B	14.0	21.1		
12	14	/	0.0	0.0	0.0	-0.1- -0.2	22.5	22.5	22.5		22.6 22.7
14**	13	/	B	+0.7	B	-0.1- +0.1	B	22.5	21.8		22.4 22.6
20*	21	/	+1.7	+0.7	0.0	0.0	22.0	21.0	20.3		
25***	35	/	-0.2	-2.2	0.0	0.0- +0.1	20.5	18.5	20.7		18.4
26***	11	/	+1.5	+1.0	0.1	-0.1	23.5	23.0	22.0		23.1

TABLE A3 (continued)

Case No	Tooth	Canal	Difference between electronically determined and actual length (mm)		Digital Display		Measured length after indication (mm)		Actual length (mm)	Corrected canal length (mm)	
			ER	NSD	ER	NSD	ER	NSD		ER	NSD
28**	31	/	+0.4	0.0	0.0	0.0	14.5	14.1	14.1		
30	21	/	+1.8	+0.8	0.0	0.0	16.0	15.0	14.2		
18a**	11	/	B	-0.5	B	-1.8	B	22.0#	21.5		23.8
18b**	21	/	B	+0.5	B	-0.8	B	17.5##	17.0		18.3

Legend: * slight periapical destruction
 ** moderate periapical destruction
 *** severe periapical destruction
 A Endo-Radar not used due to periodontal involvement
 B Endo-Radar would not indicate a digital display
 # definite stop these lengths
 ## canals previously prepared, Ledermix dressing in place, hydrogen peroxide irrigation used

TABLE A4

ANATOMIC STUDY (INVESTIGATION A)

DIGITAL DISPLAY AND DIFFERENCE BETWEEN ACTUAL AND INDICATED LENGTHS
AT THAT DISPLAY OF CANALS MEASURED IN INVESTIGATION A

Case No	Tooth	Canal	Difference between electroncally determined and actual lengths		Digital Display	
			Endo-Radar measurement	Neo-Sono-D measurement	Endo-Radar	Neo-Sono-D
1	11	/	+1.3	-1.2	0.0	0.0
3 ^a	13	/	0.0	+0.5	-0.5	0.0
3 ^b	12	/	+2.0	D	-0.5	D
3 ^c	11	/	+2.2	+1.2	0.0	0.0
4	16	MB	-1.7	-7.2	-0.4	+0.5
		DB	-5.2	-5.7	0.0	+0.4
		P	-4.6	-9.6	0.0	+1.5
5 ^a	11	/	+1.4	-1.6	0.0	0.0
5 ^b	21	/	+1.2	-1.3	0.0	0.0- 0.1
8	15	/	+1.8	-1.8	-3.9	-0.7- -0.8
10	34	/	-6.1	-9.1	0.0	+0.2
11	12	/	+0.6	+0.1	0.0	0.0
13	47	MB	-1.2	-1.7	-1.6	-0.1- 0.0 -0.4- -0.5
		ML	C	C	-2.3	-0.6- 0.0
		D	C	C	B	-0.5- -0.6

TABLE A4

Case No	Tooth	Canal	Difference between electronically determined and actual lengths		Digital Display	
			Endo-Radar measurement	Neo-Sono-D measurement	Endo-Radar	Neo-Sono-D
15	43	/	+0.1	+0.1	0.0	0.0
16	15	/	-1.3	-0.3	0.0	+0.9- +1.0
17	17	MB	-0.9	-2.7	+0.3	+0.3- +0.4
		DB	-3.5	-5.0	+0.2	+0.3- +0.4
		P	-2.7	-2.7	0.0	+0.5
19 ^a	13	/	A	-1.0	A	0.0
19 ^b	14	/	A	-2.5	A	0.0
19 ^c	43	/	A	-0.6	A	0.0
20	21	/	+1.7	+0.7	0.0	0.0
21	35	/	-0.1	-3.1	0.0	+1.5; 0.0
22 ^a	21	/	A	+0.4	A	0.0- +0.1
22 ^b	23	/	A	+0.4	A	0.0
24	16	P	-2.3	-2.3	0.0	-3.0
25	35	/	-0.2	-2.2	0.0	0.0- 0.1
26	11	/	+1.5	+1.0	-0.1	-0.1
28	31	/	+0.4	0.0	0.0	0.0
29	23	/	+1.5	+1.5	-0.8- -1.0	-0.2- +0.2
30	21	/	+1.8	+0.8	0.0	0.0

TABLE A4

Case No	Tooth	Canal	Difference between electronically determined and actual lengths		Digital Display	
					Endo-Radar measurement	Neo-Sono-D measurement
31 ^a	21	/	+0.1	+0.1; -0.4	0.0	0.0
31 ^b	22	/	+0.3	+0.3	0.0	0.0
			+0.3	+0.3	0.0	0.0- -0.1
6	31	/	A	+0.3	A	0.0- -0.1
7	16	MB	-0.1	-0.6	0.0	0.0
		DB	+0.8	+1.7	0.0	0.0
		P	+0.5	-0.5	0.0	0.0
9 ^a	12	/	-5.8	-6.8	-0.9	0.0
9 ^b	11	/	B	-7.1	B	0.0
12	14	/	0.0	0.0	0.0	-0.1- -0.2
14	13	/	B	+0.7	B	-0.1- +0.1
18 ^a	11	/	B	-0.5	B	-1.8
18 ^b	21	/	B	+0.5	B	-0.8

Legend: A device not used due to periodontal involvement
 B Endo-Radar wouldn't read
 C root fractured on removal: no measurement possible
 D no reading

APPENDIX B

CLINICAL STUDY (INVESTIGATION B)

APPENDIX B
CLINICAL STUDY (INVESTIGATION B)

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TABLE B1

CLINICAL STUDY (INVESTIGATION B)

LENGTH DETERMINATION, CANAL STATES AND DIFFERENCE BETWEEN
ELECTRONIC AND RADIOGRAPHIC LENGTH OF ALL CANALS

Case No	Age	Tooth	Canal	Instrument size	Precal.ER	Measurement ER (mm)	Measurement NSD (mm)	Canal State	Difference between electronic & radiographic lengths
									E ¹ -R E ² -R
						(E ¹)	(E ²)		
1	17	16	MB	15K	**	**	20.0	V	/ -3.1
			DB	15K	**	**	21.0	V	/ -0.7
			P	25K	**	**	22.0	V	/ -1.5
3	20	46	MB	15K	4.3	19.0	18.0	V	-3.5 -4.5
			ML	15K		19.5	18.5	V	-1.2 -1.5
			D	20K		16.0	16.0	V	0 -1.7
4	20	46	MB	15K	4.2	21.5	21.0	D ¹	+1.0 +0.5
			ML	10K		21.0	20.5	D ¹	-0.5 -1.2
			D	15K		20.0	20.5	D ¹	-3.0 -3.3

TABLE B1 (continued)

Case No	Age	Tooth	Canal	Instrument size	Precal.ER	Measurement ER (mm)	Measurement NSD (mm)	Canal State	Difference between electronic & radiographic lengths
						(E ¹)	(E ²)	E ¹ -R E ² -R	
6	34	12	/	25K	4.9	18.0	18.0	D ¹	-3.4 -3.4
7	73	12		10K	4.3, 4.0, 4.8	16.3 17.0	15.1 17.0	V	+0.1 0.0
8	42	11		10K 15K	4.2	22.0 17.0	22.0 21.5	D ²	-1.9 -1.9 +0.6 -1.4
9	65	33		15K	4.4	*	21.5	E	- -0.7
*10	18	21		20K/25K	4.2	19.0	19.0	V	- -
11	28	13		15K	4.6	24.5	24.5 24.0	V	+0.5 +0.5 +1.0
12	24	21		30K	4.6**	**	20.0	D ¹	- -1.0
# Excluded									

TABLE B1 (continued)

Case No	Age	Tooth	Canal	Instrument size	Precal.ER	Measurement ER (mm)	Measurement NSD (mm)	Canal State	Difference between electronic & radiographic lengths
						(E ¹)	(E ²)		E ¹ -R E ² -R
13	26	26	MB	10K	*	*	20.5	E	- +1.8
			DB	15K	*	*	21.0	E	- -0.3
14	35	22		15K	4.4, 4.2	*	22.0	D ¹	- -1.1
15	13	11		15K	**	**	23.0	N	- 0.0
16	14	21		100K	4.4, 4.1 4.0	21.5	21.5	D ⁴	-1.9 - -1.9 - -0.6 -0.6
17	45	11		15K	4.2, 4.2 4.2	22.5	23.0 21.5	V	+0.6 +1.1 -0.4
18	78	32		08K	**	**	20.0	V	0.0
19 ^a	17	21		20K	4.6	16.2	16.0	D ³	+0.8 +0.6
19 ^b	17	22		20K	4.6	14.5	14.5	D ³	-0.6 -0.6
20	74	21		10K	4.8	21.0	18.0	V	+3.1 -1.1

TABLE B1 (continued)

Case No	Age	Tooth	Canal	Instrument size	Precal.ER	Measurement ER (mm)	Measurement NSD (mm)	Canal State	Difference between electronic & radiographic lengths
						(E ¹)	(E ²)		E ¹ -R E ² -R
21	28	46	MB	20K	4.5	*	17.0	D ¹	-1.4
			ML	20K		*	18.0	D ¹	-3.0
			D	40K		*	17.0	D ¹	-1.5
22	33	16	MB	20K#	4.5	18.0	18.0	D ¹	-1.4
			DB	25K#		19.0	17.5	D ¹	-1.7 #
			P	30K		20.0	20.0	D ¹	-1.0 -1.0
23	14	26	MB	15K	**	**	17.0	D ¹	-3.1
			DB	10K	**	**	18.0	D ¹	-2.6
			P	20K	**	**	17.0	D ¹	-1.4

superimposition: radiograph uninterpretable

TABLE B1 (continued)

Case No	Age	Tooth	Canal	Instrument size	Precal.ER	Measurement ER (mm)	Measurement NSD (mm)	Canal State	Difference between electronic & radiographic lengths
									(E ¹ -R E ² -R)
									(E ¹ -R E ² -R)
24	20	21		40K	4.0	17.0	18.0	D ²	-2.3 -1.3
25	25	21		90K 80K	**	**	17.0 17.0	D ¹	-3.7 -3.7
26	21	36	D	20K	4.0	22.0	20.0	E	+1.3 +0.8
27	31	13		40K	4.2	24.5	24.5	D ²	+1.1 +1.1
28	65	33		20K	5.0	16.0	15.5	D ²	+1.0 +0.4
29	68	36	MB	20K	4.9**	**	18.5	E	0.0
			ML	25K		**	19.5	E	0.0
			D	40K		**	18.5	E	0.0
29 ^a	68	36	MB	35K	4.4	21.5	19.5	D ⁴	0.0 0.0
			ML	40K		20.5	20.5	D ⁴	0.0 0.0

TABLE B1 (continued)

Case No	Age	Tooth	Canal	Instrument size	Precal.ER	Measurement ER (mm)	Measurement NSD (mm)	Canal State	Difference between electronic & radiographic lengths
									E ¹ -R E ² -R
						(E ¹)	(E ²)		
30	68	36	MB	15K	5.0	*	**	D ¹ /	/
			ML	15K		*	**	D ¹ /	/
			D	15K		*	**	D ¹ /	/
31	37	15	B	20K	4.0	19.0	19.0	E +2.1	+2.1
			P	20H		16.0	16.0	E -1.3	-1.3
32	27	14	B	10K	5.0	*	24.0	N /	+2.1
			P	15K		*	22.0	N /	+1.5
33	24	46	MB	15K	**	**	16.0	E /	-1.1
			ML	15H	**	**	18.5	E /	0.0
			D	20K	**	**	18.0	E /	-0.7
34	20	13		15K	5.4	*	24.5	D ³	-0.8

TABLE B1 (continued)

Case No	Age	Tooth	Canal	Instrument size	Precal.ER	Measurement ER (mm)	Measurement NSD (mm)	Canal State	Difference between electronic & radiographic lengths
(E ¹) (E ²) E ¹ -R E ² -R									
35	24		B	15K	4.9	*	17.0	D ¹	-1.5
			P	15H		*	15.0	D ¹	-3.2
36	25	36	MB	15K	5.0	22.0	22.0	V	-0.6
			ML	15H		21.5	21.5	V	-1.2
			D	20K		22.0	22.0	V	-1.8
37	18	21		25K	4.0	24.0	24.0	D ¹	+0.9
37 ^a	18	21		50K, 30K	4.0	22.5, 22.5	22.5, 22.5	D ¹	-3.1, -3.1, -3.1
38	18	36	MB	20K	4.5	22.0	22.0	D ¹	-1.4
			ML	20H		23.5	23.5	D ¹	#
			D	25K		22.0	22.0	D ¹	-2.6

wild fluctuations in digital display

TABLE B1 (continued)

Case No	Age	Tooth	Canal	Instrument size	Precal.ER	Measurement ER (mm)	Measurement NSD (mm)	Canal State	Difference between electronic & radiographic lengths
						(E ¹)	(E ²)		E ¹ -R E ² -R

39	53	23		40K, 25K 15K	5.0	*	25.0	D ⁴	* -1.4
----	----	----	--	-----------------	-----	---	------	----------------	-----------

Legend: * Endo-Radar would not give a digital display

** no reading taken

V vital canal

D¹ debridged canal

D² debridged canal, previously filled with gutta percha. Removal with chloroform: hydrogen peroxide irrigation prior to measurement

D³ debridged canal, previously pasted filled: hydrogen peroxide irrigation prior to measurement

D⁴ debridged canal, Ledermix used as an intra-appointment dressing: hydrogen peroxide irrigation prior to measurement

E extirpated canal

N non-vital canal

TABLE B2

CLINICAL STUDY (INVESTIGATION B)

DIGITAL DISPLAY AND CORRESPONDING RADIOGRAPHIC INSTRUMENT POSITIONS
FOR ALL CANALS MEASURED IN THE CLINICAL STUDY

Case No	Tooth	Canal	Canal State	Digital Display		Distance between radiographic apex/canal termination and instrument tip (millimetres)		Peri-apical involvement
				ER	NSD	ER	NSD	
1	16	MB	V	**	0.0	/	-3.1	No
		DB	V	**	-0.1	/	-0.7	No
		P	V	**	-0.1	/	-1.5	No
3	46	MB	V	0.2- -0.3	+0.1	-3.5	-4.5	No
		ML	V	-0.1	0.0	-1.2	-1.5	No
		D	V	-0.3	+0.2	0.0	-1.7	No
4	36	MB	D ¹	0.0	-0.4	+1.0	+0.5	Yes
		ML	D ¹	*	-0.8	-0.5	-1.2	?
		D	D ¹	0.0	-0.4	-3.0	-3.3	Yes
6	12		D ¹	0.0	0.0	-3.4	-3.4	Yes
7	12		V	0.0	0.0	+0.1	0.0	Yes
8	21		D ²	+0.5	0.0	-1.9	-1.4	Yes
9	33		E	*	-0.5	/	-0.7	No
10*	21		E	0.0	0.0	***	***	Yes
11	13		V	0.0	+0.6	0.0	0.0	No

not included in study

TABLE B2 (continued)

Case No	Tooth	Canal	Canal State	Digital Display		Distance between radiographic apex/canal termination and instrument tip (millimetres)		Peri-apical involvement
				ER	NSD	ER	NSD	
12	21		D ¹	**	+0.4- +0.6 +0.4- +0.7 +0.8	/	-1.0	Yes
13	26	MB	E	**	*	/	+1.8	Yes
		DB	E	**	-0.1- 0.0	/	-0.3	Yes
		P	E	**	-0.3- +0.2	/	-4.1	Yes
14	22		D ¹	*	0.0	/	-1.1	Yes
15	11		N	**	+0.2- +0.3	/	0.0	Yes
16	21		D ⁴	*	0.0- +0.1	/	-1.9- -0.6	Open Apex
17	11		N	-0.2	-0.1- +0.1	#	-0.4	No
18	32		V	**	-0.2- -0.3	/	0.0	Yes
19	21		D ³	0.0	0.0	+0.6	+0.6	Yes
	22		D ³	*	0.0	-0.6	-0.6	Yes
20	21		V	-0.6	0.0	+3.1	-1.1	Yes

Endo-Radar reading discounted following radiographic processing error

TABLE B2 (continued)

Case No	Tooth	Canal	Canal State	Digital Display		Distance between radiographic apex/canal termination and instrument tip (millimetres)		Peri-apical involvement
				ER	NSD	ER	NSD	
21	46	MB	D ¹	*	+0.1	/	-1.4	Yes
		ML	D ¹	*	+0.2	/	-3.0	Yes
		D	D ¹	*	+0.8	/	-1.5	?
22#	16	MB	D ¹	0.0	-2.0	-1.4		No
		DB	D ¹	0.0	-3.0	-1.7		No
		P	D ¹	0.0	-3.0	-1.0		No
23	26	MB	D ¹	**	+0.1	/	-3.1	No
		DB	D ¹	**	0.0	/	-2.6	No
		P	D ¹	**	0.0- -0.2	/	-1.4	No
24	11		D ¹	0.0	0.0- +0.1	/	-1.3	No
25	21		D ¹	**	0.0- +0.1	/	-3.7	Yes
26	36	D	E	0.0	-0.1- 0.0	+1.3	+0.8	Yes
27	13		D ³	0.0	0.0	+1.0	+1.1	Yes
28	33		D ³	0.0	0.0	+1.0	+0.4	Yes

this case not included

TABLE B2 (continued)

Case No	Tooth	Canal	Canal State	Digital Display		Distance between radiographic apex/canal termination and instrument tip (millimetres)		Peri-apical involvement
				ER	NSD	ER	NSD	
29	36	MB	E	**	-2.2	/	0.0	Yes [#]
		ML	E	**	-2.0	/	0.0	Yes
		D	E	**	-1.4	/	0.0	Yes
29 ^a	36	MB	E ^{\$}	0.0	0.0	+1.4	0.0	Yes
		ML	E ^{\$}	0.0	0.0	0.0	0.0	Yes
31	15	B	E	-1.2	-1.1- -1.2	+2.1	+2.1	Yes
		P	E	*	-3.2	/	-1.3	Yes
32	14	B	N	*	-0.1	/	+2.1	Yes
		P	N	*	+1.2	/	+1.5	Yes
33	46	MB	E	**	-2.0- -2.2	/	-1.1	Yes
		ML	E	**	-2.0	/	0.0	Yes
		D	E	**	-1.7- -1.8	/	-0.7	Yes
34	13		D ^{\$}	*	-3.6	/	-0.8	Yes
35	24	B	D ⁴	*	-2.0	/	-1.5	Yes
		P	D ⁴	*	-3.6- -4.2	/	-3.2	Yes

hypercementosed tooth
\$ calcium hydroxide dressing present

TABLE B2 (continued)

Case No	Tooth	Canal	Canal State	Digital Display		Distance between radiographic apex/canal termination and instrument tip (millimetres)		Peri-apical involvement
				ER	NSD	ER	NSD	
36	36	MB	V	0.0	-0.6	-0.6	-4.5	Yes
		ML	V	-1.2- +0.1	-1.2	-1.2	-1.5	Yes
		D	V	-3.0	-1.8	-1.8	-1.7	No
37	21		D ⁴	0.0	+0.9- +1.0	+0.9	+0.9	No
37 ^a	21		D ¹	-2.0	-0.3- -1.2	-3.1	-3.1	No
				-2.0	-0.2	-3.1	-3.1	
38	36	MB	D ¹	-1.6- -1.7	-0.4	-1.4	-1.4	Yes
		ML	D ¹	-1.8	-0.4	-0.6	-0.6	?
		D	D ¹	-1.8	-0.2	-2.6	-2.6	No
39	23		D ⁴	*	-3.6	-1.4	-1.4	Yes

Legend: * Endo-Radar would not give a digital display
 ** no reading taken
 *** not known
 D¹ debrided canal
 D² debrided canal, previously filled with gutta percha. Removal with chloroform: hydrogen peroxide irrigation prior to measurement
 D³ debrided canal, previously paste filled: hydrogen peroxide irrigation prior to measurement
 D⁴ debrided canal, Ledermix used as an intra-appointment dressing: hydrogen peroxide irrigation prior to measurement
 E extirpated canal
 N non-vital canal

TABLE B3

CLINICAL STUDY (INVESTIGATION B)

ACCURACY OF DIGITAL DISPLAY FOR THOSE CANALS MEASURED
WITH THE NEO-SONO-D IN THE CLINICAL STUDY

Case No	Canal	Digital Display Neo-Sono-D	Radiographic Instrument Position (millimetres)	Canal State	Periapical involvement
1	MB	0.0	-3.1	V	No
3	ML	0.0	-1.5	V	No
6		0.0	-3.4	D ¹	Yes
7		0.0	0.0	V	Yes
8		0.0	-1.4	D ²	Yes
10		0.0	\$	E	Yes
14		0.0	-1.1	D ¹	Yes
19 ^a		0.0	+0.6	D ³	Yes
19 ^b		0.0	-0.6	D ³	Yes
20		0.0	-1.1	V	Yes
23	DB	0.0	-2.6	D ¹	No
25		0.0	-3.7	D ¹	Yes
27		0.0	+1.1	D ²	Yes
28		0.0	+0.4	D ²	Yes
29 ^a		0.0	+1.3	E ³	Yes
13	DB	0.0- -0.1	-0.3	E	Yes
26	D	0.0- -0.1	+0.8	E	Yes
23	P	0.0- -0.2	-1.4	D ¹	No
16	DB	-0.1	-0.7	V	No
16	D	-0.1	-1.5	V	No
32	B	-0.1	+2.1	N	Yes
38	D	-0.2	-2.6	D ¹	No
18		-0.2- -0.3	0.0	V	Yes
4	MB	-0.4	+0.5	D ¹	Yes
4	D	-0.4	-3.3	D ¹	Yes
38	MB	-0.4	-1.4	D ¹	Yes
38	ML	-0.4	-0.6	D ¹	Yes
9		-0.5	-0.7	E	No
36	MB	-0.6	-4.5	V	Yes
4	ML	-0.8	+1.2	D ¹	?
31	B	-1.1- -1.2	+2.1	E	Yes
29	D	+2.1	0.0	E	Yes
36	ML	-1.2	0.0	V	Yes
36	D	-1.8	-1.7	V	No

TABLE B3 (continued)

Case No	Canal	Digital Display Neo-Sono-D	Radiographic Instrument Position (millimetres)	Canal State	Periapical involvement
33	P	-1.7- -1.8	-0.7	E	Yes
22	MB	-2.0	#	V	No
29	ML	-2.0	0.0	E	Yes
29	MB	-2.2	0.0	E	Yes
33	MB	-2.0- -2.2	-1.1	E	Yes
33	ML	-2.0	0.0	E	Yes
35	B	-2.9	-1.5	D ⁴	Yes
22	DB	-3.0	) ##	V	No
22	P	-3.0	)	V	No
31	P	-3.2	-1.3	E	Yes
34		-3.6	-0.8	D ³	Yes
39		-3.6	-1.4	D ⁴	Yes
35	P	-3.6- -4.2	-3.2	D ³	Yes
24		0.0- +0.1	-1.3	D ²	No
25 ²		0.0- +0.1	-3.7	D ¹	Yes
16		0.0- +0.1	-0.6	D ⁴	Yes
21	MB	+0.1	-1.4	D ¹	Yes
3	MB	+0.1	-4.5	V	No
23	MB	+0.1	-3.1	D ¹	No
21	ML	+0.2	-3.0	D ¹	Yes
3	D	+0.2	-1.7	V	No
37 ^a		+0.2	-3.1	D ⁴	No
15		+0.2- +0.3	-0.0	N	Yes
12 ¹		+0.4- +0.6	-1.0###	D ¹	Yes
12 ²		+0.4- +0.6	-1.0###	D ¹	Yes
11		+0.8	0.0	V	No
21	D	+0.8	-1.5	D ¹	?
37		+0.9- +1.0	+0.9	D ³	No
29 ^a	ML	0.0	+1.3	E ³	Yes
32	P	+1.2	+1.5	N	Yes
17		-0.1- +0.1	-0.4	N	No
13	D	-0.3- +0.2	-4.1	E	Yes
37 ^a		-0.3- -1.2	-3.1	D ⁴	No

TABLE B4

CLINICAL STUDY (INVESTIGATION B)

ACCURACY OF DIGITAL DISPLAY FOR THOSE CANALS MEASURED
WITH THE ENDO-RADAR IN THE CLINICAL STUDY

Case No	Canal	Digital Display Neo-Sono-D	Radiographic Instrument Position (millimetres)	Canal State	Periapical involvement
4	MB	0.0	+1.0	D ¹	Yes
4	D	0.0	-3.0	D ¹	Yes
6		0.0	-3.4	D ¹	Yes
7		0.0	+0.1	V	Yes
11		0.0	0.0	V	No
19 ^a		0.0	+0.6	D ¹	Yes
22	MB	0.0	-1.4	V	No
22	DB	0.0	-1.7	V	No
22	D	0.0	-1.0	V	No
24		0.0	-2.3	D ¹	No
26		0.0	+1.3	E	Yes
27		0.0	+1.1	D ¹ \$	Yes
28		0.0	+1.0	D ¹ \$	Yes
29 ^a	MB	0.0	+1.4	D ¹ \$	Yes
29 ^a	ML	0.0	0.0	D ¹ \$	Yes
36	MB	0.0	-0.6	V	Yes
37		0.0	+0.9	D ¹	No
37 ^a		0.0	-3.1	D ¹	No
38	MB	-1.6- -1.7	-1.4	D ¹	No
	ML	-1.8	-0.6	D ¹	No
	D	-1.8	-2.6	D ¹	No
36	D	-3.0	-1.8	V	No
36	ML	+1.2- +0.1	-1.2	V	No

Legend: D¹ debrided canal
D² debrided canal, previously filled with gutta percha. Removal with chloroform: hydrogen peroxide irrigation prior to measurement
D³ debrided canal, previously paste filled: hydrogen peroxide irrigation prior to measurement
D⁴ debrided canal, Ledermix used as an intra-appointment dressing: hydrogen peroxide irrigation prior to measurement
E extirpated canal
N non-vital canal
\$ remnants of calcium hydroxide present
couldn't be measured
couldn't be measured due to dentinal blockage
perforated canal

APPENDIX C

LABORATORY STUDY (INVESTIGATION C)

APPENDIX C
LABORATORY STUDY (INVESTIGATION C)

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TABLE C1

LABORATORY STUDY (INVESTIGATION C)

DIGITAL DISPLAY, RADIOGRAPHIC INSTRUMENT POSITION AND DIFFERENCE
FOR ALL CANALS INCLUDED IN INVESTIGATION C

Radio- graph No.	Tooth	Canal	Instrument size		length		Digital Display		Radiograph Instrument Position		E ₁ R	E ₂ R
			ER	NSD	ER	NSD	(E ₁)	(E ₂)	(mm) (R)			
1 ^a	33			15K		2.45		-0.1- 0.0*	+0.4			+0.4
1 ^b	33		15K		25.0		0.0		+0.4	+0.4		
2 ^a	13			15K		27.0		0.0*	+0.4			+0.4
2 ^b	13		15K		27.5		0.0		+0.9	+0.9		
3 ^a	33			15K		27.5		0.0- -0.1	+0.1 ^s			+0.1
3 ^b	33		15K		27.5		0.0		+0.1 ^s	+0.1		
4 ^a	33			20K		22.5		0.0- +0.1	0.0			0.0
4 ^b	33		20K		23.0		0.0		0.0	0.0		
5 ^a	11			15K		22.0		0.0- -0.1	+0.3			+0.3
5 ^b	11		15K		22.0		0.0		+0.3	+0.3		
6 ^a	23			20K		18.0		-0.1- 0.0**	0.0			0.0
6 ^b	23		20K		18.0 ⁺		0.0		0.0	0.0		
7 ^a	31			15K		20.5 ⁺		-0.5*	0.0 ^{ss}			-0.5
7 ^b	31		15K		21.0		0.0		0.0 ^{ss}	0.0		
8 ^a	21			20K		26.5		-0.2- -0.1*	-0.5 ^s			-0.4
8 ^b	21		20K		28.0		0.0		0.0	0.0		

TABLE C1 (continued)

Radio- graph No.	Tooth	Canal	Instrument size		length		Digital Display		Radiograph Instrument Position		E ₁ R	E ₂ R
			ER	NSD	ER	NSD	(E ₁)	(E ₂)	(mm) (R)			
9 ^a	34			15K		21.0		-0.1- -0.2	0.0 ^{\$}			-0.1
9 ^b	34		15K		21.0		0.0		0.0 ^{\$}	0.0		
10 ^a	22			15K		19.5		0.0- +0.1 ^{**}	+0.7			+0.7
10 ^b	22		15K		20.0		0.0		+0.7	+0.7		
11 ^a	41			15K		19.0		-0.1- 0.0 ^e	0.0			0.0
11 ^b	41		15K		18.0 ⁺		0.0 [*]		0.0 ^{\$}	0.0		
12 ^a	13			15K		30.0		0.0	-0.1			-0.1
12 ^b	13		15K		31.0		0.0		0.0 ^{\$}	0.0		
13 ^a	35			15K		26.0		-0.1- +0.1 ^{**} -0.2- +0.6 ^e	+0.1			-0.3
13 ^b	35		15K		26.0		0.0		+0.1	+0.1		
14 ^a	45			25K		17.0 ⁺		0.0 ^{*2}	-0.2			-0.2
14 ^b	45		25K		17.0		0.0		-0.2	-0.2		
15 ^a	33			15K		19.5		-2.3- +0.1 ^e	-0.5			-0.5
15 ^b	33		15K		19.5		0.0		-0.5	-0.5		
16 ^a	31			15K		19.0		0.0 ^e -0.6- +0.3	+0.7			+0.7
16 ^b	31		15K		20.0		0.0		+0.7	+0.7		

TABLE C1 (continued)

Radio- graph No.	Tooth	Canal	Instrument size		length		Digital Display		Radiograph Instrument Position		E ₁ R	E ₂ R
			ER	NSD	ER	NSD	(E ₁)	(E ₂)	(mm) (R)			
17 ^a	44			15K		23.0		0.0 ^a	+0.1			+0.1
17 ^b	44		15K		23.0		0.0 ^a		+0.1	+0.1		
18 ^a	23			20K		22.5		0.0- +0.1* ^a	0.0			0.0
18 ^b	23		25K		21.5		0.0 ^a		+0.6	+0.6		
19 ^a	14			20K		21.0		0.0*	0.0			0.0
19 ^b	14		20K		21.0		0.0		0.0	0.0		
20 ^a	25			15K		24.0 ⁺		0.0	0.0			0.0
20 ^a	25			20K		25.0		-0.4* ^a	0.0			-0.4
20 ^b	25		15K		24.5		0.0		0.0	0.0		
20 ^b	25		20K		26.0		0.0		0.0	0.0		
21 ^a	37	MB		15H		23.0		-2.2- -2.3	0.0			-2.2
21 ^a	37	ML		10K		21.0		-0.7- -0.8	-0.4			-0.3
21 ^a	37	D		15K		21.0		-1.0- -1.1	-0.8			-0.2
21 ^c	37	MB	15H		23.0		?		-0.8	?		
21 ^c	37	ML	10K		21.0		-1.6- -0.3		0.0	-0.6		
21 ^c	37	D	15K		21.0		-1.9		-0.7	-1.2		

TABLE C1 (continued)

Radio- graph No.	Tooth	Canal	Instrument size		length		Digital Display		Radiograph Instrument Position		E ₁ R	E ₂ R
			ER	NSD	ER	NSD	(E ₁)	(E ₂)	(mm) (R)			
22 ^a	16	MB		15K		18.5		+0.5	-0.4			-0.9
22 ^a	16	DB		10K		19.5		+3.5	-0.3			-3.2
22 ^a	16	P		15K		22.0		-1.1	-0.7			-0.5
22 ^c	16	MB	15K		18.5		+0.3 ^e 0.0		-0.5		-0.5	
22 ^c	16	DB	10K		19.5		? ^e 0.0		-0.6		-0.6	
22 ^c	16	P	15K		22.0		-2.4 ^e 0.0		-0.3		-0.3	
23 ^a	38	MB		15K		16.0		-0.7- +0.5	0.0*			-0.5
23 ^a	38	MLI		15K		17.0		-0.3- 0.0- +0.6	-0.5*			-0.5
23 ^a	38	D		20K		18.5		0.0	+1.1*			+1.1
23 ^c	38	MB	15K		17.0		0.0		0.0		0.0	
23 ^c	38	MLI	15K		17.0		0.0		0.0		0.0	
23 ^c	38	D	20K		18.5		0.0		+1.6		+1.6	
24 ^a	16	MB		15K		17.5		-1.4	0.0			-1.4
24 ^a	16	DB		15K		19.0		-0.6	0.0			-0.6
24 ^a	16	P		20K		21.0		+0.2- +0.3	0.0			+0.2
24 ^c	16	MB	15K		17.5		-0.8		0.0		-0.8	
24 ^c	16	DB	15K		19.0		-1.0		0.0		-1.0	
24 ^c	16	P	20K		21.0		+0.4		0.0		-0.4	

TABLE C1 (continued)

Radio- graph No.	Tooth	Canal	Instrument size		length		Digital Display		Radiograph Instrument Position (mm) (R)		E ₁ R	E ₂ R
			ER	NSD	ER	NSD	(E ₁)	(E ₂)				
25 ^a	38	MB**	15K	15K	17.5	17.5	-1.0	-0.2	0.0	+1.0	-0.2	
25 ^a	38	ML**	15K	15K	16.5	16.5	-1.0- -0.9	-0.2	-1.4	-0.5	-1.2	
25 ^c	38	D	15K	15K	16.5	16.5	0.0- +0.1	-0.6	-0.3	-0.3	+0.3	
26 ^a	36	MB	15K	15K	16.0	16.0	+0.3	+0.6- +0.7	-0.3	-0.6	+0.9	
26 ^a	36	ML	15K	15K	16.5	16.5	+0.3	+0.7- +0.8	0.0	+0.3	+0.7	
26 ^a	36	D	20K	20K	17.0	17.0	-0.1	-1.3- -1.4	0.0	-0.1	-0.6	
26 ^c	36	MB	15K	15K	16.0	16.0	-0.8- -0.9	-0.1- 0.0	0.0	-0.8	0.0	
27 ^a	14	B	15K	15K	20.0	20.0	+1.2	+1.4	+0.1	+1.1	+1.3	
27 ^a	14	P	15K	15K	18.0	18.0	+0.4	+0.3	-1.5 ⁺	-1.9	-1.8	
28 ^a	11		20K	20K	25.0	25.0	+0.9	+0.5	+0.1	+0.8	+0.4	
29 ^a	44		15K	15K	21.5	21.5	-2.1	-0.7- -0.6	-0.7	-1.4	0.0	
30 ^a	15	B	15H	15H	22.0	22.0	-1.4	-0.6- -0.5	-0.5	-0.8	0.0	
30 ^a	15	P	20K	20K	20.0	20.0	-1.6	-0.7- -0.8	-0.9	-0.7	-0.2	
31 ^a	37	MB	15K	15K	19.0	19.0	-0.1	0.0- +0.1*	0.0 ⁺	-0.1	0.0	
31 ^a	37	ML	10K	10K	19.0	19.0	-0.1	+0.1- 0.0*	0.0 ⁺	-0.1	0.0	
31 ^a	37	D	15K	15K	20.0	20.0	+1.0	+0.8	0.0	+1.0	+0.8	

TABLE C1 (continued)

Radio- graph No.	Tooth	Canal	Instrument size		length		Digital Display		Radiograph Instrument Position		E ₁ R	E ₂ R
			ER	NSD	ER	NSD	(E ₁)	(E ₂)	(mm) (R)			
32 ^a	34		15K	15K	22.0	22.0	-0.9	-0.4	-0.3		-0.6	-0.1
33 ^a	47	MB	10K	10K	19.5	19.5	?	-1.9- -2.0	0.0		-	-1.9
33 ^a	47	ML	/	/	/	/	/	/	?		/	/
33 ^a	47	D	15K	15K	16.0	16.0	?	-4.4	-2.1		-	-2.1
34 ^a	11			30K		16.0		+0.6- +0.7	-0.8			-1.4
34 ^c	11		30K		16.0		0.0		-1.1		-1.1	
35 ^a	22			30K		19.5		+0.1- +0.2	-0.5			-0.6
35 ^c	22		30K		19.5		-1.2 ^e 0.0		-0.8		-0.6 -0.8	
36 ^{aee}	23		30K	30K	20.0 ⁺	20.0 ⁺	-1.6- -1.7 ^e	-0.6- -0.7*	-1.2		-0.4	-0.6
36 ^b	23		30K		20.5 ⁺		-0.1- 0.0 ^e		-0.9		-0.8	
40 ^a	25	B	20K	20K	21.0	21.0	+1.2	+2.1- +1.5*	0.0		+1.2	+1.5
41 ^a	36	MB		15K		21.0		+1.0 ⁺	-0.9			-1.9
41 ^a	36	ML		10K		21.5		+1.0 ⁺	+0.6			+0.4
41 ^a	36	D		20K		20.5		+0.7	-1.0			-1.7
41 ^b	36	MB	15K		21.0		+1.0		-0.9		-1.9	
41 ^b	36	ML	10K		21.5		+1.0		+0.6		+0.4	
41 ^b	36	D	20K		20.5		+0.7		-1.0		-1.7	

TABLE C1 (continued)

Legend:	*	display difficult to stabilize
	**	display more difficult to stabilize
	***	pulp condition appeared to be necrotic
	@	instrument movement produces display change
	@@	digital display Endo-Radar 36a changed to 36b but rotating instrument in canal
	\$	difficulty in making measurement on radiograph
	\$\$	greater difficulty in making measurement on radiograph
	%	these measurements not plotted due to variable nature of digital display
	%%	those 2 canals confluent
	+	measurement fell between 0.5mm graduations on scale
	?	no reading
	/	couldn't be found

TABLE C2
LABORATORY STUDY (INVESTIGATION C)
POSITION AND INSTRUMENT DETAILS FOR CANALS
MEASURED BY METHOD "AX"

Radio- graph No.	Tooth	Canal	Digital Display		Radiograph Instrument Position (mm) (R)	Difference between electronic and radio- graphic instrument positions	
			Endo-Radar (E ₁)	Neo-Sono-D (E ₂)		E ₁ R	E ₂ R
21 ^a	37	MB		-2.2- -2.3	0.0		-2.2
		ML		-0.7- -0.8	-0.4		-0.3
		D		-1.0- -1.1	-0.8		-0.2
21 ^c	37	MB	no reading		-0.8	no reading	
		ML	-1.6- -0.3		0.0	-0.6	
		D	-1.9		-0.7	-1.2	
23 ^a	38	MB		-0.7- +0.5	0.0		-0.5
		ML		-0.3- 0.0- +0.6	-0.5		-0.5
		D		0.0	+1.1		+1.1
23 ^c	38	MB	0.0		0.0	0.0	
		ML	0.0		0.0	0.0	
		D	0.0		+1.6	+1.6	
34 ^a	11	/		+0.6- +0.7	-0.8		-1.4
34 ^c	11	/	0.0		-1.1	-1.1	
38 ^a	34	/	+1.2	+2.0	+0.4	+0.8	+1.6

TABLE C3
LABORATORY STUDY (INVESTIGATION C)
POSITION AND INSTRUMENT DETAILS FOR CANALS
MEASURED BY METHOD "AY"

Radio- graph No.	Tooth	Canal	Digital Display		Radiograph Instrument Position (mm) (R)	Difference between electronic and radio- graphic instrument positions	
			Endo-Radar (E ₁)	Neo-Sono-D (E ₂)		E ₁ R	E ₂ R
1 ^a	33	/		-0.1- 0.0*	+0.4		+0.4
1 ^b	33	/	0.0		+0.4	+0.4	
2 ^a	13	/		0.0*	+0.4		+0.4
2 ^b	13	/	0.0		+0.9	+0.9	
3 ^a	33	/		0.0- -0.1	+0.1		+0.1
3 ^b	33	/	0.0		+0.1	+0.1	
4 ^a	33	/		0.0- +0.1	0.0		0.0
4 ^b	33	/	0.0		0.0	0.0	
5 ^a	11	/		0.0- +0.1	+0.3		+0.3
5 ^b	11	/	0.0		+0.3	+0.3	
6 ^a	23	/		+0.1- 0.0*	0.0		0.0
6 ^b	23	/	0.0		0.0	0.0	
7 ^a	31	/		-0.5*	0.0		-0.5
7 ^b	31	/	0.0		0.0	0.0	
8 ^a	21	/		-0.2- -0.1*	-0.5		-0.4
8 ^b	21	/	0.0		0.0	0.0	
9 ^a	34	/		-0.1- -0.2	0.0		-0.1
9 ^b	34	/	0.0		0.0	0.0	

TABLE C3 (continued)

Radio- graph No.	Tooth	Canal	Digital Display		Radiograph Instrument Position (mm) (R)	Difference between electronic and radio- graphic instrument positions	
			Endo-Radar (E ₁)	Neo-Sono-D (E ₂)		E ₁ R	E ₂ R
10 ^a	22	/		0.0- +0.1**	+0.7		+0.7
10 ^b	22	/	0.0		+0.7	+0.7	
11 ^a	41	/		-0.1- 0.0**	0.0*		0.0
11 ^b	41	/	0.0		0.0	0.0	
12 ^a	13	/		0.0	-0.1		-0.1
12 ^b	13	/	0.0		0.0	0.0	
13 ^a	35	/		+0.1- -0.1** +0.2- -0.6	+0.1		-0.2 -0.3
13 ^b	35	/	0.0		+0.1	+0.1	
14 ^a	45	/		0.0*	-0.2		-0.2
14 ^b	45	/	0.0		-0.2	-0.2	
15 ^a	33	/		0.0	-0.5		-0.5
15 ^b	33	/	0.0		-0.5	-0.5	
16 ^a	31	/		0.0	+0.7	+0.7	
16 ^b	31	/	0.0		+0.7		+0.1
18 ^a	23	/		0.0- +0.1	0.0		0.0
18 ^b	23	/	0.0		+0.6	+0.6	
19 ^a	14	/		0.0*	0.0		0.0
19 ^b	14	/	0.0		0.0	0.0	

TABLE C3 (continued)

Radio- graph No.	Tooth	Canal	Digital Display		Radiograph Instrument Position (mm) (R)	Difference between electronic and radio- graphic instrument positions	
			Endo-Radar (E ₁)	Neo-Sono-D (E ₂)		E ₁ R	E ₂ R
20 ^a	25	B		0.0	0.0		0.0
20 ^a	25	P		-0.4	0.0		-0.4
20 ^b	25	B	0.0		0.0	0.0	
20 ^b	25	P	0.0		0.0	0.0	

Legend: * difficulty in stabilizing display
 ** greater difficulty in stabilizing display

TABLE C4
LABORATORY STUDY (INVESTIGATION C)
POSITION AND INSTRUMENT DETAILS FOR CANALS
MEASURED BY METHOD "BX"

Radio- graph No.	Tooth	Canal	Digital Display		Radiograph Instrument Position (mm) (R)	Difference between electronic and radio- graphic instrument positions	
			Endo-Radar (E ₁)	Neo-Sono-D (E ₂)		E ₁ R	E ₂ R
22 ^a	16	MB		+0.5	-0.4		-0.9
22 ^a	16	DB		+3.5	-0.3		-3.2
22 ^a	16	P		-1.1	-0.7		-0.4
22 ^a	16	MB	0.0		-0.5	-0.5	
22 ^a	16	DB	0.0		-0.6	-0.6	
22 ^a	16	P	0.0		-0.3	-0.3	
24 ^a	16	MB		-1.4	0.0		-1.4
24 ^a	16	DB		-0.6	0.0		-0.6
24 ^a	16	P		+0.2- +0.3	0.0		+0.2
24 ^a	16	MB	-0.8		0.0	-0.8	
24 ^a	16	DB	-1.0		0.0	-1.0	
24 ^a	16	P	+0.4		0.0	-0.4	
25 ^a	38	MB	-1.0	-0.2	0.0	+1.0	-0.2
25 ^a	38	ML	-1.0- -0.9	-0.2	-1.4	-0.5	-1.2
25 ^c	38	D	0.0- +0.1	-0.6	-0.3	-0.3	+0.3
26 ^a	36	MB	+0.3	+0.6- +0.7	-0.3	-0.6	+0.5
26 ^a	36	ML	+0.3	+0.7- +0.8	0.0	+0.3	+0.7
26 ^a	36	D	-0.1	-1.3- -1.4	0.0	-0.1	+0.6
26 ^c	36	MB	-0.8- -0.9	-0.1- 0.0	0.0	-0.8	0.0

TABLE C4 (continued)

Radio- graph No.	Tooth	Canal	Digital Display		Radiograph Instrument Position (mm) (R)	Difference between electronic and radio- graphic instrument positions	
			Endo-Radar (E ₁)	Neo-Sono-D (E ₂)		E ₁ R	E ₂ R
27 ^a	14	B	+1.2	+1.4	+0.1	+1.1	+1.3
27 ^a	14	P	+0.4	+0.3	-1.5	-1.9	-1.8
28 ^a	11	/	+0.9	+0.5	+0.1	+0.8	+0.4
29 ^a	44	/	-2.1	-0.7- -0.6	-0.7	-1.4	0.0
30 ^a	15	B	-1.4	-0.6- -0.5	-0.5	-0.8	0.0
30 ^a	15	P	-1.6	-0.7- -0.8	-0.9	-0.7	
31 ^a	37	MB	-0.1	0.0- +0.1*	0.0	-0.1	0.0
31 ^a	37	ML	-0.1	+0.1- 0.0	0.0	-0.1	0.0
31 ^a	37	D	+1.0	+0.8	0.0	+1.0	+0.8
32 ^a	34	/	-0.9	-0.4	-0.3	-0.6	-0.1
33 ^a	47	MB	A	-1.9- -2.0	0.0	-	-1.9
33 ^a	47	ML	B	-	-	-	-
33 ^a	47	D	A	-4.4	-2.1	-	-2.1
35 ^a	22	/		+0.1- +0.2	0.5	-	-0.6
35 ^c	22	/	0.0-1.2**		0.8	-0.6 -0.8	
36 ^a	23	/	1.6-1.7**	-0.6- -0.7	1.2	-0.4	-0.6
36 ^b	23		0.1-0.0**		0.9	-0.8	
38 ^a	34		+1.2	+2.0	0.4	+0.8	+1.6

TABLE C4 (continued)

Radio- graph No.	Tooth	Canal	Digital Display		Radiograph Instrument Position (mm) (R)	Difference between electronic and radio- graphic instrument positions	
			Endo-Radar (E ₁)	Neo-Sono-D (E ₂)		E ₁ R	E ₂ R
40 ^a	25	B	+1.2	+2.0- +1.5*	0.0	1.2	1.5
41 ^a	36	MB	1.0	1.0*	0.9	-1.9	-1.9
41 ^a	36	ML	1.0	1.0*	0.6	+0.4	+0.4
41 ^a	36	D	0.7	0.7	1.0	-1.7	-1.7

Legend: * difficulty in stabilizing display
 ** display changed to following display when instrument rotated, but not moved apically
 A no reading taken
 B canal could not be found

TABLE C5

LABORATORY STUDY (INVESTIGATION C)

POSITION AND INSTRUMENT DETAILS FOR CANALS
MEASURED BY METHOD "BY"

Radio- graph No.	Tooth	Canal	Digital Display		Radiograph Instrument Position (mm) (R)	Difference between electronic and radio- graphic instrument positions	
			Endo-Radar (E ₁)	Neo-Sono-D (E ₂)		E ₁ R	E ₂ R
17 ^a	44	/		0.0	+0.1		+0.1
17 ^b	44	/	0.0		+0.1	+0.1	

TABLE C6
LABORATORY STUDY (INVESTIGATION C)
MEASUREMENTS TAKEN ON TEETH STORED IN FORMALIN

Radio- graph No.	Tooth	Canal	Digital Display		Radiograph Instrument Position	
			Endo-Radar (E ₁)	Neo-Sono-D (E ₂)	(mm)	(R)
1 ^a	33	/	-	-0.1- 0.0	+0.4	
1 ^b	33	/	0.0	-	+0.4	
2 ^a	13	/	-	0.0	+0.4	
2 ^b	13	/	0.0	-	+0.9	
3 ^a	33	/	-	-0.1- 0.0	+0.1	
3 ^b	33	/	0.0	-	+0.1	
4 ^a	33	/	-	0.0- +0.1	0.0	
4 ^b	33	/	0.0	-	0.0	
5 ^a	11	/	-	-0.1- 0.0	+0.3	
5 ^b	11	/	0.0	-	+0.3	
6 ^a	23	/	-	-0.1- 0.0	0.0	
6 ^b	23	/	0.0	-	0.0	
7 ^a	31	/	-	-0.5	0.0	
7 ^b	31	/	0.0	-	0.0	
8 ^a	21	/	-	-0.2- 0.1	-0.5	
8 ^b	21	/	0.0	-	0.0	
9 ^a	34	/	-	-0.1- -0.2	0.0	
9 ^b	34	/	0.0	-	0.0	

TABLE C6 (continued)

Radio- graph No.	Tooth	Canal	Digital Display		Radiograph Instrument Position (mm) (R)
			Endo-Radar (E ₁)	Neo-Sono-D. (E ₂)	
10 ^a	22	/	-	0.0- +0.1	+0.7
10 ^b	22	/	0.0	-	+0.7
11 ^a	41	/	-	-0.1- 0.0	0.0
11 ^b	41	/	0.0	-	0.0
12 ^a	13	/	-	0.0	-0.1
12 ^b	13	/	0.0	-	0.0
13 ^a	35	/	-	-0.1- +0.1 -0.2- +0.6	+0.1
13 ^b	35	/	0.0	-	+0.1
27 ^a	14	B	+1.2	+1.4	+0.1
		P	+0.4	+0.3	-1.5
28 ^a	11	/	+0.9	+0.5	+0.1
29 ^a	44	/	-2.1	-0.7- -0.6	-0.7
30 ^a	15	B	-1.4	-0.6- -0.5	-0.5
		P	-1.6	-0.7- -0.8	-0.9
31 ^a	37	MB	-0.1	0.0- +0.1	0.0
		ML	-0.1	0.0- +0.1	0.0
		D	+0.1	+0.8	0.0
32 ^a	34	/	-0.9	-0.4	-0.3

TABLE C6 (continued)

Radio- graph No.	Tooth	Canal	Digital Display		Radiograph Instrument Position (mm) (R)
			Endo-Radar (E ₁)	Neo-Sono-D (E ₂)	
33 ^a	47	MB	A	-1.9- -2.0	0.0
		ML*	-	-	-
		D	A	-4.4	-2.1
34 ^a	11	/	-	+0.6- +0.7	-0.8
34 ^c	11	/	0.0	-	-1.1
35 ^a	22	/	-	+0.1- +0.2	-0.5
35 ^c	22	/	-1.2/0.0**	-	-0.8
36 ^a	23	/	-1.6- -1.7\$	-0.6- -0.7	-1.2
36 ^b	23	/	-0.1- 0.0	-	-0.9
38 ^a	34	/	+1.2	+2.0+	+0.4
40 ^a	25	B	+1.2	+2.1- +1.5	0.0
41 ^a	36	MB	+1.0	+1.0	-0.9
		ML	+1.0	+1.0	+0.6
		D	+0.7	+0.7	+1.0

Legend: \$ next reading obtained by very little apical movement of file
+ 0.0 reading obtained by very little apical movement of file
* canal couldn't be found
** twisting instrument produced change in display accompanied by very little apical movement
A no reading

TABLE C7
LABORATORY STUDY (INVESTIGATION C)
MEASUREMENTS TAKEN ON TEETH STORED IN TAP WATER

Radio- graph No.	Tooth	Canal	Digital Display		Radiograph Instrument Position	
			Endo-Radar (E ₁)	Neo-Sono-D (E ₂)	(mm)	(R)
14 ^a	45	/	-	0.0	-0.2	
14 ^b	45	/	0.0	-2.3- +0.1	-0.2	
15 ^a	33	/	-	0.0	-0.5	
15 ^b	33	/	0.0	-	-0.5	
16 ^a	31	/	-	-0.6- +0.3	+0.7	
16 ^b	31	/	0.0	-	+0.7	
17 ^a	44	/	-	0.0	+0.1	
17 ^b	44	/	0.0	-	+0.1	
18 ^a	23	/	-	0.0- +0.1	0.0	
18 ^b	23	/	0.0	-	+0.6	
19 ^a	14	/	-	0.0	0.0	
19 ^b	14	/	0.0	-	0.0	
20 ^a	25	B ¹	-	0.0	0.0	
20 ^b	25	P ²	-	-0.4*	0.0	
20 ^b	25	B ²	0.0	-	0.0	
20 ^b	25	P ¹	0.0	-	0.0	

TABLE C7 (continued)

Radio- graph No.	Tooth	Canal	Digital Display		Radiograph Instrument Position (mm) (R)
			Endo-Radar (E ₁)	Neo-Sono-D (E ₂)	
21 ^a	37	MB	-	-2.2- -2.3	0.0
		ML	-	-0.7- -0.8	-0.4 ⁺
		D	-	-1.0- -1.1	-0.8
21 ^c	37	MB	?	-	-0.8
		MB	-1.6- -0.3	-	0.0
		D	-1.9	-	-0.7
22 ^a	16	MB	-	+0.5	-0.4
		DB	-	+3.5	-0.3
		P	-	-1.1	-0.7
		MB	+0.3- 0.0*	-	-0.5
		DB	? - 0.0*	-	-0.6
		P	-2.4- 0.0*	-	-0.3
23 ^a	38	MB	-	-0.7- +0.5	0.0
		MLI	-	-0.3- 0.0- +0.6	-0.5
		D	-	0.0	+1.1
23 ^c	38	MB	0.0	-	0.0
		MLI	0.0	-	0.0
		D	0.0	-	+1.6

TABLE C7 (continued)

Radio- graph No.	Tooth	Canal	Digital Display		Radiograph Instrument Position (mm) (R)
			Endo-Radar (E ₁)	Neo-Sono-D (E ₂)	
24 ^a	16	MB	-	-1.4	0.0
		DB	-	-0.6	0.0
		P**	-	+0.2- +0.3	0.0
24 ^c	16	MB	-0.8	-	0.0
		DB	-1.0	-	0.0
		P**	+0.4	-	0.0
25 ^a	38	MB	-1.0	-0.2	0.0
		ML	-1.0- -0.9	-0.2	-1.4
25 ^c	38	D	0.0- +0.1	-0.6	-0.3
26 ^a	36	MB	+0.3	+0.6- +0.7	-0.3
		MLI	+0.3	+0.7- +0.8	0.0
		D	-0.1	-1.3- -1.4	0.0
26 ^c	36	/	-0.8- -0.9	-0.1- 0.0	0.0

Legend: ? no reading
 * reading changed valued when file advanced slightly apically
 ** apical 1/3 fractured during extraction
 + 0.0 reading obtained by very little apical movement of file

APPENDIX D

STATISTICAL SUMMARY

APPENDIX D
STATISTICAL SUMMARY

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APPENDIX D
STATISTICAL SUMMARY
ANATOMIC STUDY (INVESTIGATION A)

All canals (difference between electronically determined length and actual length)
E₁-A (Endo-Radar) E₂-A (Neo-Sono-D)

	E ₁ -A (Endo-Radar)	E ₂ -A (Neo-Sono-D)
dn	2.2819	2.7896
x	-0.5	-1.5
n	33	44
Ex	-16.5	-66.7

Canals associated with radiographic periapical destruction (difference between electronically determined length and actual length)

	E ₁ -A (Endo-Radar)	E ₂ -A (Neo-Sono-D)
dn	2.3210	2.5719
x	-0.5	-1.6769
n	16	26
Ex	-8.1	-43.6

Canals not associated with radiographic periapical destruction (difference between electronically determined length and actual length)

	E ₁ -A (Endo-Radar)	E ₂ -A (Neo-Sono-D)
dn	2.2811	3.0436
x	-0.6	1.3166
n	16	18
Ex	-9.6	-23.7

Canals with contents assessed as "vital" (difference between electronically determined and actual length)

	E ₁ -A (Endo-Radar)	E ₂ -A (Neo-Sono-D)
dn	2.3243	2.8439
x	-0.7434	-1.886
n	23	29
Ex	-17.1	-54.7

APPENDIX D (continued)

Canals with contents assessed as "non-vital" (difference between electronically determined and actual length)

	E ₁ -A (Endo-Radar)	E ₂ -A (Neo-Sono-D)
dn	2.0756	2.5324
x	-0.06	-0.8
n	10	15
Ex	0.6	-12

All canals (difference between corrected electronically determined length and actual length)

	E ₁ -A (Endo-Radar)	E ₂ -A (Neo-Sono-D)
dn	2.3121	3.2447
x	-0.07	1.625
n	10	32
Ex	-0.7	-52

Endo-Radar Pre-Calibration Values

dn	1.0633
x	4.268
n	35
Ex	149.4

APPENDIX D
STATISTICAL SUMMARY
CLINICAL STUDY (INVESTIGATION B)

All canals (difference between electronically determined length and radiographic length)

	E ₁ -A (Endo-Radar)	E ₂ -A (Neo-Sono-D)
dn	1.6431	1.5099
x	-0.62	-0.95
n	35	66
Ex	-21.7	-63

Canals associated with radiographical periapical destruction (difference between electronically determined length and radiographic length)

	E ₁ -A (Endo-Radar)	E ₂ -A (Neo-Sono-D)
dn	1.6552	1.4828
x	-0.45	-0.6552
n	16	38
Ex	-7.2	-24.9

Canals not associated with radiographic periapical destruction (difference between electronically determined length and radiographic length)

	E ₁ -A (Endo-Radar)	E ₂ -A (Neo-Sono-D)
dn	1.4309	1.4716
x	-1.1277	-1.2885
n	18	26
Ex	-20.3	-33.5

Canals with contents assessed as "vital" (difference between electronically determined and radiographic length)

	E ₁ -A (Endo-Radar)	E ₂ -A (Neo-Sono-D)
dn	1.6541	1.3757
x	-0.4	-1.1571
n	10	14
Ex	-4	-16.2

APPENDIX D (continued)

Canals with contents assessed as "non-vital" (difference between electronically determined and radiographic length)

	E ₁ -A (Endo-Radar)	E ₂ -A (Neo-Sono-D)
dn	1.6304	1.5493
x	-0.71	-0.92
n	25	51
Ex	-17.7	-46.8

Endo-Radar Pre-Calibration Values

dn	0.3761
x	4.518
n	33
Ex	149.1

APPENDIX D
 STATISTICAL SUMMARY
 LABORATORY STUDY (INVESTIGATION C)

All canals (difference between electronically determined length and radiographic length)

	E ₁ -A (Endo-Radar)	E ₂ -A (Neo-Sono-D)
dn	0.7312	0.768
x	-0.141	-0.121
n	59	56

Method of Instrument Placement

Method "Ax" (difference between electronically determined length and radiographic length)

	E ₁ -A (Endo-Radar)	E ₂ -A (Neo-Sono-D)
dn	0.9391	1.1445
x	-0.071	-0.3
n	7	8

Method "Ay" (difference between electronically determined length and radiographic length)

	E ₁ -A (Endo-Radar)	E ₂ -A (Neo-Sono-D)
dn	0.3338	0.3013
x	0.155	-0.333
n	20	21

Method "Bx" (difference between electronically determined length and radiographic length)

	E ₁ -A (Endo-Radar)	E ₂ -A (Neo-Sono-D)
dn	0.821	1.138
x	-0.35	-0.45
n	32	34

NOTE: There is only one canal in category "By"

APPENDIX D (continued)

Storage Media

Tap water (difference between electronically determined length and radiographic length)

	E ₁ -A (Endo-Radar)	E ₂ -A (Neo-Sono-D)
dn	0.551	0.619
x	-0.033	0.126
n	39	38

Formalin (difference between electronically determined length and radiographic length)

	E ₁ -A (Endo-Radar)	E ₂ -A (Neo-Sono-D)
dn	0.969	1.139
x	-0.38	-0.32
n	20	20

