



CLINICAL ARTICLE

Anatomic Endodontic Technology (AET) – a crown-down root canal preparation technique: basic concepts, operative procedure and instruments

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Abstract

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Aim To illustrate the conceptual basis and the operative procedure of the Anatomic Endodontic Technology™ (AET) technique and to illustrate the specific instruments used in each phase.

Summary The basic characteristics of the AET™ technique are reported. The instruments and procedure are described in three phases: coronal access, coronal-middle preparation and apical preparation. In the first phase, correct cavity design is described. In the coronal-middle phase, the use of four stainless steel shaping instruments, powered by a reciprocating handpiece is described, incorporating a brushing-milling action against canal walls. During the apical phase, dedicated apical stainless steel and NiTi hand instruments are used to complete the preparation. The stainless steel apical files are used with a 1/4 turn and withdrawal movement whilst the NiTi are used in 360° rotary motion.

Key learning points

- Most current canal shaping techniques do not prepare all the canal walls and can result in over-enlargement in some areas.
- AET™ defines three regions of the canal: coronal (from the cavo-surface of the access cavity), coronal-middle, and apical.
- Coronal-middle instrumentation is undertaken with four mechanically driven stainless steel shaping instrument used in brushing-milling action against canal walls.
- Apical preparation is completed by hand and with the formation of a stop.

Keywords: crown-down, endodontic instruments, root canal anatomy, shaping.

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Introduction

One of the aims of root canal preparation is to achieve a progressively and uniformly conical shape within the canal. However, this may not always be possible in canals that do not have a circular morphology.

On the basis of early studies (Hess 1925, Kraus 1969), Latrou classified root canals depending on the cross-section shape as: laminar or tubular (Latrou 1980). Laminar canals can be further divided into semilunar, 'figure of 8' or straight, whilst tubular canals may be circular, triangular or oval (Fig. 1).

Superimposed on these gross morphological variations, histological sections and clearing techniques show that most canal systems have further anatomical complexities and apical deltas which may be impossible to instrument (Fig. 2). The great disparity between buccolingual and mesiodistal dimensions and taper (Fig. 3a,b) determines that many canals are of an oval shape (Kerekes & Tronstad 1977a,b,c, Wu *et al.* 2000, Bellucci & Perrini 2002), and it may be difficult to enlarge them in all dimensions by traditional methods.

The basic concepts of Anatomic Endodontic Technology (AET™) are founded on these anatomical observations.

Basic concepts of the AET technique

Since its first description by Talbot (1880), and subsequent '3-tempi' (three-steps) technique (Riitano 1976), crown-down shaping with tapered instruments has become an

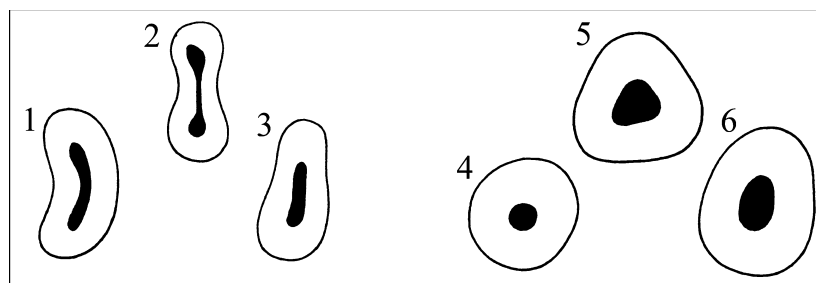


Figure 1 Latrou's (1980) classification. Laminar: (1) semilunar, (2) 'figure of 8' shaped, (3) straight. Tubular: (4) circular, (5) triangular, (6) oval.

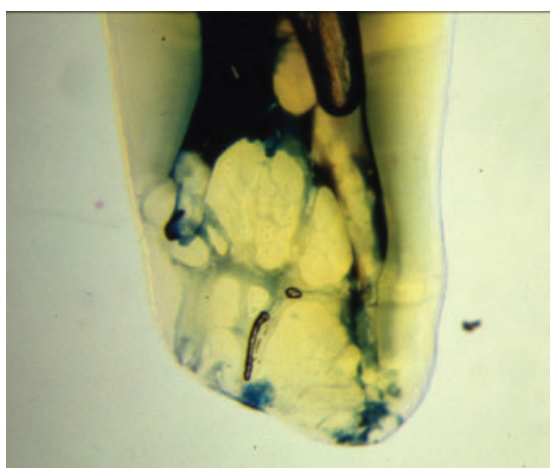


Figure 2 Complex anatomy which may be impossible to instrument.

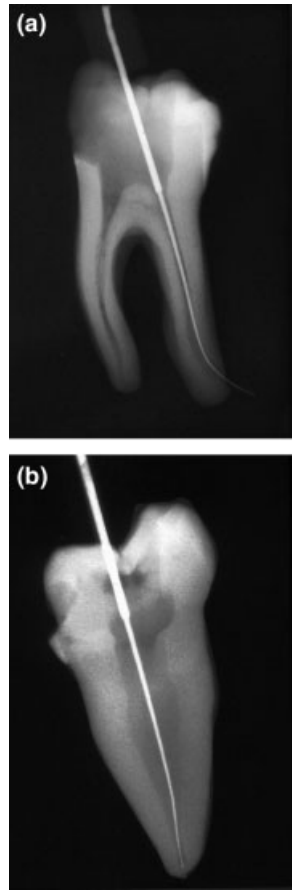


Figure 3 (a) Bucco-lingual view of a lower molar, (b) The same distal canal in mesio-distal view.

accepted and rational norm in endodontic practice (Marshall & Pappin 1980, Scianamblo 1993).

The concept of producing predetermined, conical preparations in oval canals is, however, flawed, with areas of the canal being at risk of over-enlargement and others sites being untouched (Wu & Wessellink 2001, Barbizam *et al.* 2002, Rödiger *et al.* 2002, Weiger *et al.* 2002, Wu *et al.* 2003).

By contrast, the AETTM technique permits a perimetric or circumferential preparation of the coronal and middle canal thirds. Stainless steel mechanical instruments, specifically designed for this technique, (ShapingsTM, Ultradent Inc., South Jordan, UT, USA) are manually guided by the operator against every portion of each wall (Fig. 4). The dentine is selectively removed and weakening of the walls of the canal or perforation in those areas where they are thinner is avoided, as previously described by others (Abou-Rass *et al.* 1980).

Concepts of the 'operative canal' and straight line access refinement

In the AETTM technique the preparation includes the pulp chamber walls and the root canal is conceptualized from the occlusal surface of the tooth to the root apex. Figure 5 illustrates the division of a tooth into thirds in classical anatomical (Laurichesse 1986, Scianamblo 1993) and AETTM 'operative canal' terms (Riitano 1980).

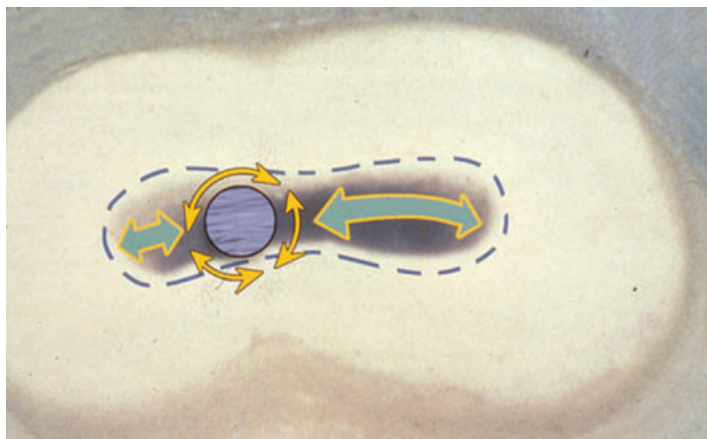


Figure 4 In the coronal and middle third, perimetral, circumferential flaring makes instruments contact the entire dentinal surface.

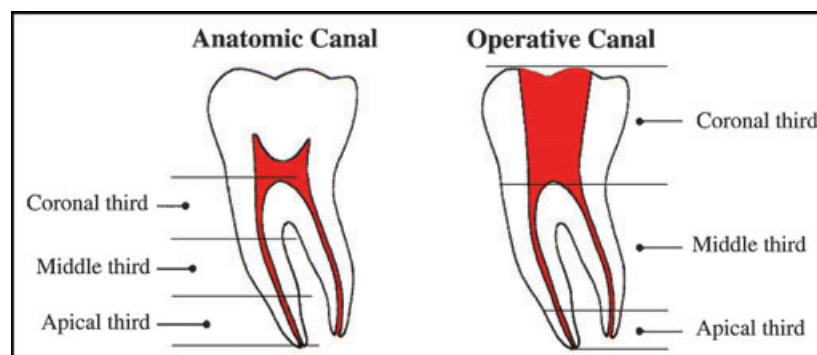


Figure 5 'Anatomic' canal vs. 'operative' canal.

Briefly, Riitano (1980) describes:

1. a coronal 'third' extending from the occlusal surface to the pulp chamber floor in multi-rooted teeth and to the neck of the tooth in single rooted teeth;
2. a middle 'third' extending from the end of the coronal third to 3–4 mm from the apex;
3. an apical 'third' corresponding to the final 3–4 mm of the canal, ending at the apical foramen.

The AET™ preparation technique comprises three phases:

1. coronal access (using the Access Bur Kit, Ultradent Inc.);
2. coronal-middle preparation (using Shaping files™; Ultradent Inc.);
3. apical preparation (using Apical files, Ultradent Inc.).

Operative procedure

Good quality preoperative radiographs are essential to inform the process.

Coronal Phase

Aims. To open and clean the pulp chamber and identify canal orifices.

Instruments and method. 'Access bur kit' (Fig. 6) comprising:

1. Round and tapered diamond burs to prepare the access cavity.
2. Non end-cutting burs to remove the chamber roof in multi-rooted teeth without damaging the chamber floor and to remove dentine overhangs and residual enamel interferences.
3. Safe-point diamond bur to prepare axial line access by removing dentine interferences.

Coronal-middle Phase

Aims. Circumferential shaping following the anatomic contour and eliminating interferences in the middle section of the canal in order to obtain the straightest possible access towards the apical region. The second phase is termed coronal-middle since the instruments used in this phase are designed to prepare not only the middle third of the 'operative canal' (OC) but also to refine the preparation of the coronal third that has been initiated during the first phase.

Instruments. Shaping files™ (Ultradent Inc.): four stainless steel (S1, SC, S2, S3) (Fig. 7) instruments with a square cross-section (Fig. 8–10); instrument details are shown in Table 1. The blades of the instrument extend throughout its length from the tip almost up to the handle thus also covering the coronal section of the OC (Fig. 11). The flexible tip of the instrument is rounded (Fig. 12).

Shaping files™ are available in lengths of 16 mm (X-short), 20 mm (short), 24 mm (medium) and 27 mm (long). The Endo-Eze® (Ultradent Inc., South Jordan, UT, USA) handpiece is a dedicated handpiece for the Shaping files™ with a 30 ° right-30 ° left reciprocating action. It is possible to vary the insertion depth of the instrument within the head of the handpiece, via a push button collet. This permits four different working lengths for each instrument length, as follows:

- 13, 14, 15 and 16 mm for the 16 mm length;
- 17, 18, 19 and 20 mm for the 20 mm length;
- 21, 22, 23 and 24 mm for the 24 mm length;
- 24, 25, 26 and 27 mm for the 27 mm length;



Figure 6 Access bur kit.

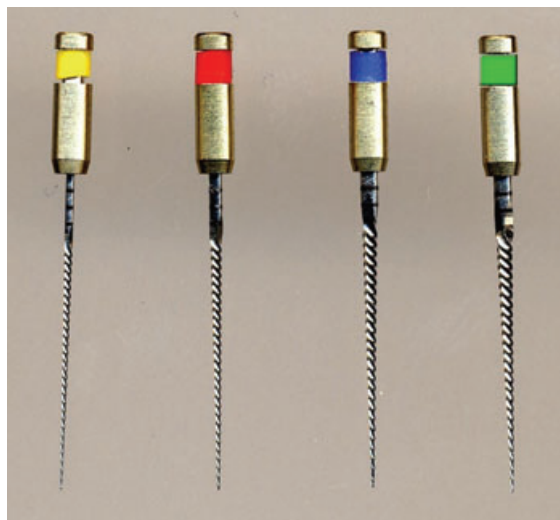
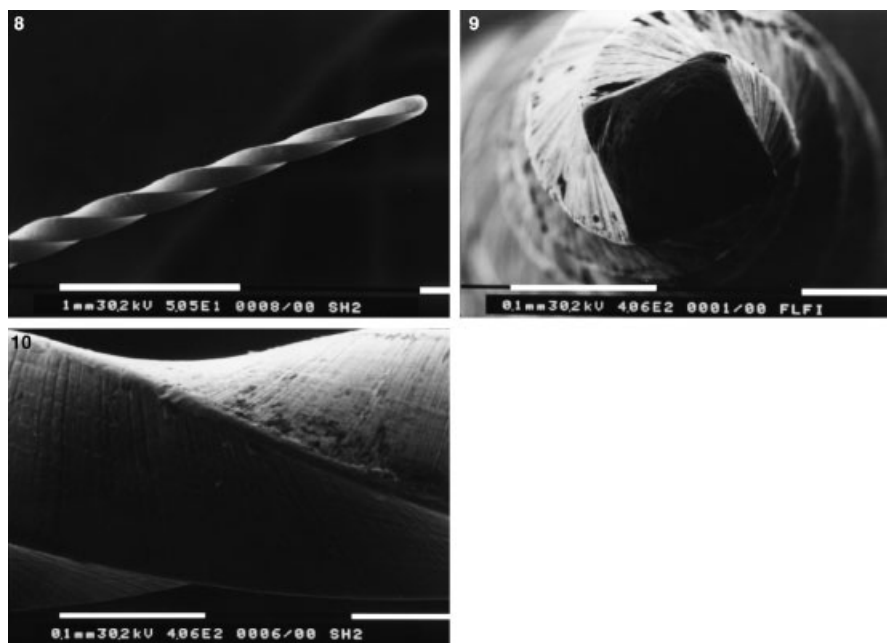


Figure 7 The four Shaping™ files, S1, SC, S2, S3.



Figures 8–10 SEM pictures of Shaping™ files (courtesy of Dr A Butti and Dr N.M. Grande, Catholic University of Sacred Heart, Rome).

In this way, the head of the handpiece works as a stop for the file at the working length and provides internal continuous spray irrigation; the internal irrigation is connected with the waterline unit (a disinfected solution can be used) and its aim is to remove the gross debris created from the action of the Shaping™ instruments. During the procedure canals are also irrigated with 5% NaOCl and 17% EDTA irrigation.

Method.

1. The coronal-middle working length for the Shaping files™ (Fig. 7) is determined as follows:

Table 1 Technical characteristic of the Shaping™ instruments

	Shaping 1	Shaping C	Shaping 2	Shaping 3
Tip diameter	0.10 mm	0.13 mm	0.13 mm	0.13 mm
Taper	2.5%	3.5%	4.5%	6%
Identification colour	Yellow	Red	Blue	Green
Lengths available	16, 20, 24, 27 mm for all Shapings			
Working part	Extended over the 16 mm ISO standard, almost to the handle			

**Figure 11** The extended cutting surface of an AET Shaping compared with a NiTi rotary file (System GT – Dentsply, Ballaigues, Switzerland).

- in teeth with vital noninfected pulp the canal length (CL) is determined with an apex locator and small K-files and confirmed radiographically. Coronal-middle length is obtained by subtracting 3 mm from this length;
 - in infected canals the coronal-middle length is obtained by subtracting 3–4 mm from the estimated tooth length on the pre-operative radiograph, to prevent the transport of bacteria and debris into the apical region of the canal.
2. Complete the manual glide path and canal negotiation using the first Shaping™ file (yellow) (Fig. 13) before starting mechanical preparation.
 3. Insert Shaping files into the Endo-Eze® hand-piece at the Coronal-middle length established, and direct the instruments with their reciprocating action circumferentially, brushing the canal walls in order to remove interferences (Fig. 14) and obtain straight-line coronal-radicular access (Figs 15 and 16). Active brushing should be performed only when the Shapings™ instruments are being pulled out of the canal. The four shaping instruments are used sequentially for approximately 1 min each in the sequence shaping 1 (yellow-S1), shaping 'C' (red-SC), shaping 2 (light blue-S2) and shaping 3 (green-S3). They should be pushed laterally mainly using the upper half of the instruments.



Figure 12 SEM picture of Shaping™ file tip (courtesy of Dr A. Butti and Dr N.M. Grande, Catholic University of Sacred Heart, Rome).



Figure 13 Manual glide path established with Shaping™ 1 (yellow).

Apical Phase

Aims. To shape and clean the apical third of the canals whilst respecting the electronically determined apical limit and maintaining the original apical foramen diameter as narrow as possible. To create an 'apical stop' for obturation.

In the apical few millimetres the canals tend to be circular (Curson 1972, Wu *et al.* 2000). Hence, the preparation of the apical region may be completed by means of a cutting rotary movement. Safe NiTi hand instruments are used to achieve the goal of preserving apical curvature and respecting anatomy.

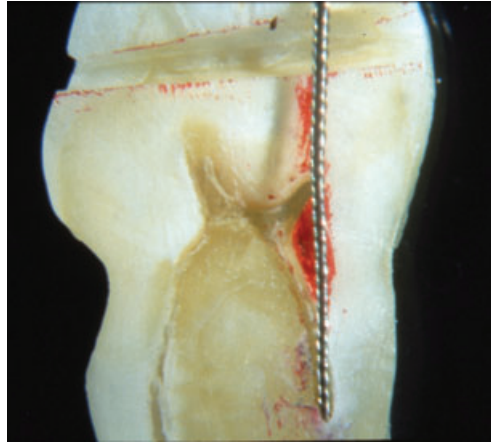


Figure 14 Dental 'interference' (coloured in red) which do not permit straight access of the instruments to the apical portion of the root canal.



Figure 15 Straight line corono-radicular access obtained with Shaping™ files.

Instruments. Apical files (Ultradent Inc.) (Fig. 17) in lengths of 19, 23, 27 and 30 mm:

- manual Stainless steel files with tip diameters ranging from 0.08 mm up to 0.20 mm with a square cross-section;
- manual NiTi files with tip diameters ranging from 0.25 to 0.50 mm and above with a square cross-section and round noncutting tip.

Apical files have a 0.02 taper in sizes 0.8–20 and a 0.025 taper in sizes 25–50 and above; they have an active part 10 mm in length.

Method. Re-evaluate the canal length (CL) and establish the Apical Limit in order to obtain the Apical Working Length (AWL). The AWL is determined by subtracting 0.5 mm from the electronically determined CL (Figs 18–23).

In most canals, having completed preparation with Shaping files, the size 25 hand Apical NiTi used in manual rotary motion will easily reach the AWL. If this is not possible, use

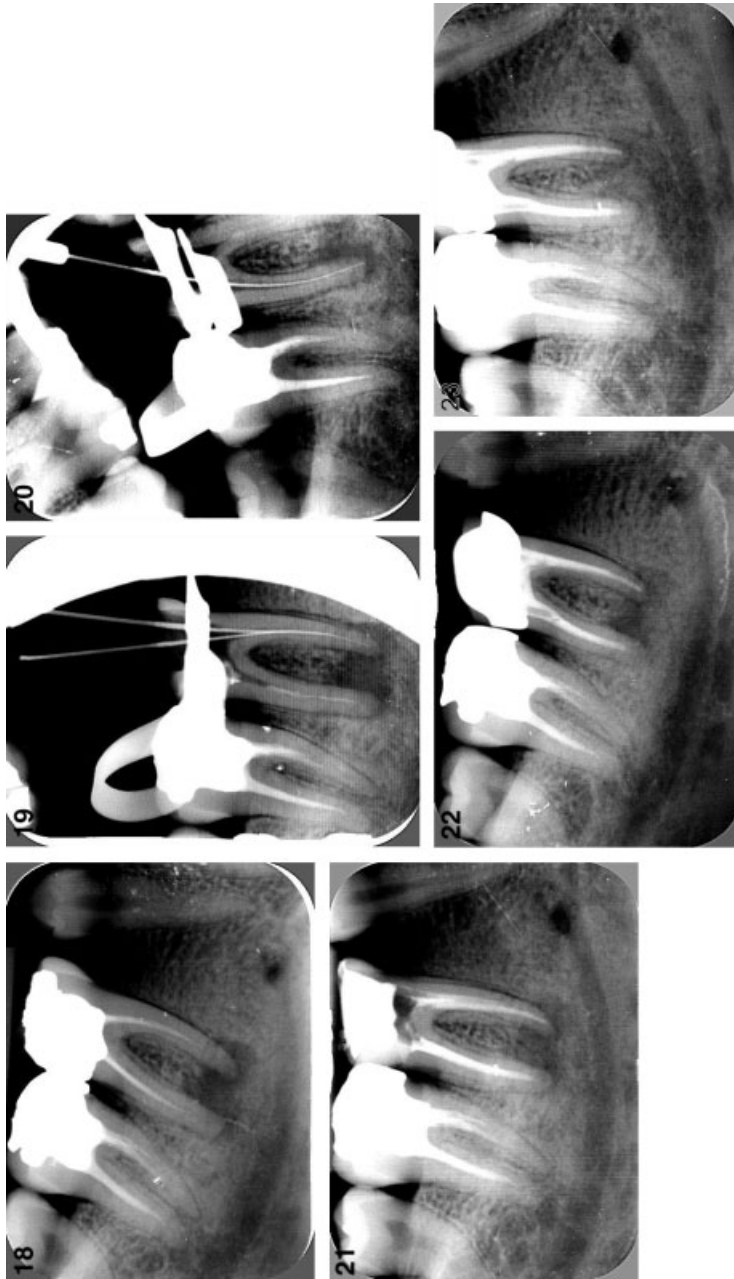


Figure 16 Position of the instrument before and after straight line corono-radicular access.



Figure 17 Apical files.

stainless steel Apical files with diameters ranging from size 08 up to size 20 and with 1/4 turn and withdrawal movements until reaching the AWL with the size 25 Apical NiTi. Continue with the Apical NiTi (size 30, 35, 40, etc.) until reaching the final Diameter of Apical Preparation (DAP); alternating EDTA and NaOCl should be used as irrigants. The DAP is to be established on the basis of the morphometric data of the tooth which is being treated (Kerekes & Tronstad 1977a,b,c, Wu *et al.* 2000, Tan & Messer 2002, Marroquín *et al.* 2004). However, apical enlargement should not be considered as having been completed until the Apical files are extracted from the canal filled with clean dentinal



Figures 18–23 Tooth 4.6 retreatment using AET technique preparation and cold lateral condensation of gutta-percha. Six months recall shows almost complete healing of the apical lesion.



Figures 24–25 Tooth 1.2 vital treatment using AET technique preparation and obturation with cold lateral condensation of gutta-percha.

debris. In the author's opinion, the minimum diameter should never be less than size 35 (Card *et al.* 2002, Rollison *et al.* 2002) (Figs 24 and 25).

Conclusions

The great disparity between bucco-lingual and mesio-distal dimensions and taper of canals illustrates the relationship between the instrument and the canal walls. The concept of the canal beginning from the occlusal surface is essential, since it allows the operator to immediately identify all enamel and dentinal interferences. The elimination of interferences (Fig. 13) straightens the coronal and middle thirds, placing them on the same axis and opening a direct pathway to the apex (Fig. 16). Using the AET™ technique it is possible with the Shaping™ instruments to simultaneously complete the initial negotiation, circumferential canal enlargement, elimination of all interferences and straight line access of the first '2/3' of any canal regardless of its diameter, morphology and length.

The AET™ instruments, coherently with the crown-down technique, have been designed with a stronger and sharper bulk in the upper half (extended over the 16 mm ISO standard) which engages the coronal and middle thirds and is employed for their circumferential and anatomical enlargement. The rounded tip is not active and serves only for guidance of the instrument within the canal.

Disclaimer

The Author has sold all rights of AET™ system to Ultradent Inc., South Jordan, Utah, USA. Whilst this article has been subjected to Editorial review, the opinions expressed, unless specifically indicated, are those of the author. The views expressed do not necessary represent best practice, or the views of the IEJ Editorial Board, or of its affiliated Specialist Societies.

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