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The LightSpeed System

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Successful endodontic therapy calls for optimized chemomechanical preparation of root canals, disinfection where required, oburation, and placement of a leakage-free coronal restoration. Traditionally, root canals are prepared using stainless-steel hand files and reamers. Until approximately 10 years ago, most root canals were prepared by hand instruments whose basic design was patented by the Kerr Co. in 1915 and comprised a 2% taper with 16-mm-long cutting surfaces [1]. Specifications and tolerances for hand files currently comply with American Dental Association Specification No. 28 (Council of Dental Materials and Devices, 1976) and obtained international recognition (International Standards Organization [ISO] status) in 1981 [1]. Progress in file development stagnated somewhat until the mid-1980s when the balanced force technique and its associated files were described [2]. Changes in canal preparation evolved rapidly when two innovative concepts developed independently of each other during the late 1980s. One was the use of nickel-titanium to manufacture hand instruments and the second was the development of an innovative engine-driven instrument, the Canal Master U (Brasseler, Savannah, Georgia) [3,4]. Subsequently, engine-driven endodontic instruments with this innovative design were manufactured from nickel-titanium and were marketed as LightSpeed instruments (LightSpeed Endodontics, San Antonio, Texas).

Design of lightspeed instruments

LightSpeed instruments are quite unique; thus, it is important to describe the innovative features that make up the instrument. The unique features include their sizes; short cutting heads; and long, noncutting, taperless shafts (Fig. 1).

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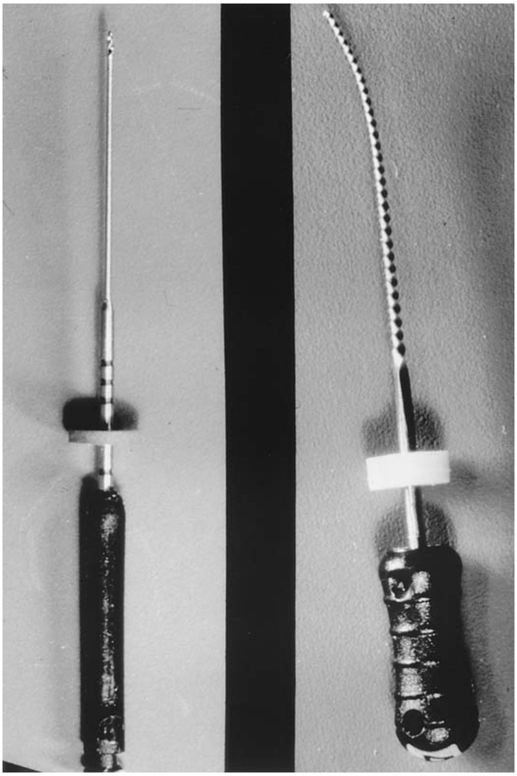


Fig. 1. Overview of a LightSpeed instrument (*left*) with its short cutting head and thin noncutting taperless shaft compared with a K-FlexoFile (Dentsply-Maillefer, Ballaigues, Switzerland) (*right*) with its 16-mm-long cutting surface.

Sizes

A set of LightSpeed instruments totals 26 and encompasses sizes 20 to 140; the instruments are marketed in lengths of 21 mm, 25 mm, and 31 mm. In addition to the color-coded full ISO sizes, LightSpeed instruments also have half-sizes, placing sizes 22.5, 27.5, 32.5, respectively, between sizes 20 and 25, between sizes 25 and 30, and between sizes 30 and 35. The last two half-sizes are sizes 57.5, and 65, which fit between sizes 55 and 60 and between sizes 60 and 70, respectively. The half-sizes are color-coded exactly as the previous size, but also have white or black markings or engraved rings on the instrument's handles. These markings or rings are important, because it is impossible to identify the full size from its corresponding half-size by color alone.

Cutting heads

LightSpeed cutting heads are designed to operate in a continuous clockwise rotation and have three radial lands and three U-shaped spiral grooves between the radial lands. Although cutting surfaces of most engine-driven instruments are 16 mm long, the smallest (size 20) and largest (size 140) LightSpeed cutting heads are 0.25 mm and 2.25 mm long, respectively. In addition, LightSpeed is the only rotary system whose cutting heads have three different geometric shapes (Fig. 2). The first five LightSpeed instruments (sizes 20 through 30) have short, noncutting pilot tips and a 75-degree cutting angle. Instrument size 32.5 is a transition instrument with a slightly longer noncutting pilot tip and a 33-degree cutting angle. All other instruments (sizes 35 through 140) have longer and more slender noncutting pilot tips than do the transitional instrument and a 21-degree cutting angle. The major differences between LightSpeed instruments and conventional stainless steel and nickel-titanium hand files are summarized in Table 1. Cutting heads of all LightSpeed instruments terminate in noncutting pilot tips (Fig. 3). The spiral grooves help to transport debris coronally, whereas the radial lands and noncutting pilot tips help rotating LightSpeed instruments to remain better centered in canals (Fig. 4).

Thin shafts

LightSpeed is the only rotary system whose instruments have thin, taperless, noncutting shafts. This design maximizes the flexibility of nickel-titanium and enables instruments to negotiate primary, secondary, and tertiary curves in both the bucco-lingual and mesio-distal planes. Fig. 5 illustrates a cross-section, 1.5 mm from the root apex, showing different parts of two cutting heads in two canals with different working lengths. In one canal, the noncutting pilot tip is sectioned, whereas in the other, the radial lands and spiral grooves are sectioned.

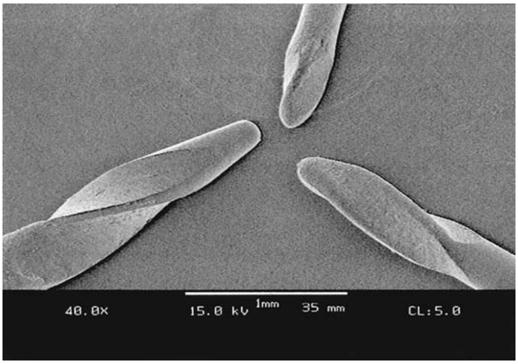


Fig. 2. SEM photomicrograph of three LightSpeed cutting heads showing differences between sizes 20 (*top*), 32.5 (*right*), and 40 (*left*) and the radial lands and spiral grooves (original magnification ×40).

Table 1
Differences between LightSpeed instruments and conventional stainless-steel endodontic files

	LightSpeed instruments	Conventional hand files
Metal/alloy	Nickel-titanium	Stainless steel
Shaft diameter	0.16 to 0.51 mm	Increases linearly
Length of cutting head (mm)	0.25 (20) to 2.25 (140)	16 size
Tip angles	Varies; 21, 33, and 75 degrees	Similar for all files
Noncutting pilot tip	Yes	No[a]
Tip design constant	No	Yes
Intermediate sizes	Yes	No[b]
Tolerance	±0.005 mm[c]	±0.02 mm
Smallest size	20	08
Largest size	140	140

[a] Some files have a batt geometry.
[b] Golden Mediums (Dentsply Maillefer, Ballaigues, Switzerland) have intermediate sizes.
[c] Steve Senia, DDS, San Antonio, Texas, personal communication, July 2003.

Shanks and handles

The thin, taperless nickel-titanium shaft enlarges at one end to become the shank, which in turn inserts into the aluminum handle. The shank is marked with rings that indicate distances from the instrument's tip. For the 21-mm and 25-mm instruments, the junction of the shaft and shank is 18 mm from the tip, and for the 31-mm instrument, the distance is 22 mm. Although the 21-mm instruments have only one ring on the shank, which is 20 mm from the tip, the 25-mm instruments have three rings indicating distances of 20 mm, 22 mm, and 24 mm from the tip. In contrast, the 31-mm instruments have four rings on the shank, indicating distances of 24 mm, 26 mm, 28 mm, and 30 mm from the tip. Junctions between shanks and color-coded handles are 21 mm, 25 mm, and 31 mm from the tips for the 21-mm, 25-mm, and 31-mm long instruments, respectively. The markings on the

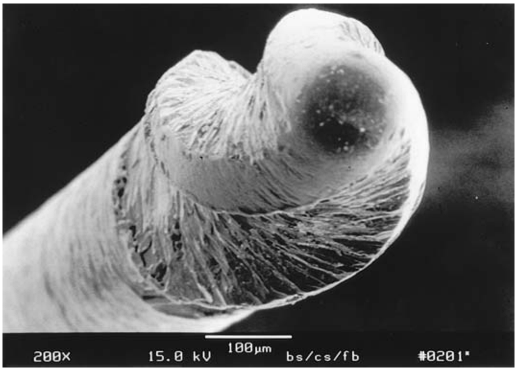


Fig. 3. SEM photomicrograph of a LightSpeed cutting head showing the noncutting pilot tip, radial lands, spiral grooves, and part of the taperless shaft in an unusual perspective (original magnification ×200).

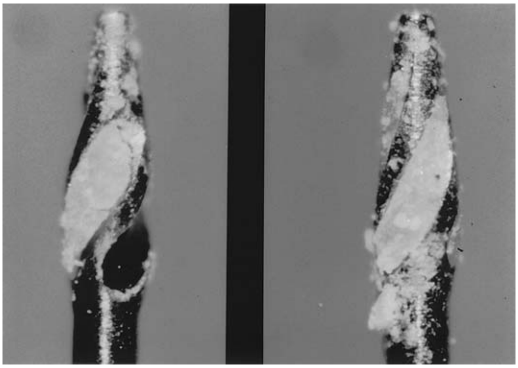


Fig. 4. Front and back of a LightSpeed cutting head showing dentin debris filling spaces between radial lands.

shanks allow clinicians to select a wide variety of reference points without being limited to cuspal tips or incisal edges.

Principles of the lightspeed technique

Ideally, LightSpeed instruments should rotate at a constant speed between 1500 and 2000 revolutions per minute (rpm) without exceeding 2000 rpm. Foot pedals on dental units should be adjusted to maintain the constant speed, although cordless handpieces are recommended because of their low cost, constant speed, constant torque, and ease of use. LightSpeed instruments operate optimally at high rpm in low-torque motors; the constant rpm is important because nickel-titanium does not tolerate repeated changes in torque. Instruments should already be rotating as they enter the canal, continue rotating while cutting canal walls, and stopped only when the instrument is removed from the canal orifice.

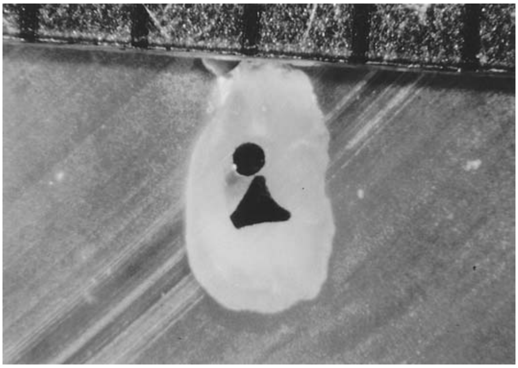


Fig. 5. Root apices of a maxillary first premolar with the LightSpeed MAR instruments fixed in situ and cross-sectioned 1.5 mm from the tip showing the noncutting pilot tip and the cutting blades in the two canals. Working length is different in the two canals (original magnification ×64, scale = 0.5 mm).

LightSpeed instruments require a straight-line access to the mid-root area. Consequently, cavity walls should be shaped so that they guide the rotating instruments unhindered to the mid-root area. This may require rasping coronal canal overhangs using size 15, 20, and 25 Hedström files (Dentsply Maillefer, Ballaigues, Switzerland). Because the smallest LightSpeed instrument is a size 20, working lengths should first be reached with a loose-fitting, size 15 hand file. In very narrow canals it may be necessary to first reach the working length with size 08 or size 10 K-Files (Dentsply Maillefer), preferably using the "Balanced Force" technique [2]. Copious irrigation is important and it is advisable to maintain a reservoir of the irrigant in the pulp chamber. Irrigants help to remove debris that rapidly collects within the cutting flutes, thus maintaining the instruments' cutting efficiency. A proven concept is to irrigate alternately with sodium hypochlorite and a liquid ethylenediaminetetraacetic acid, using the latter when LightSpeed is working in the canal and as the final flush.

With LightSpeed, always use progressively larger instruments in the correct sequence from small to large, never skipping a size to gain time. However, one way to gain time is to use two or more handpieces. Two handpieces expedite instrument changeovers because although the clinician uses one handpiece, the chairside assistant can fit the next LightSpeed instrument into the second handpiece and set the length, if rubber stops are used. Once a LightSpeed instrument has reached its desired length, do not linger at that point and immediately withdraw the rotating instrument from the canal. No further shaping can occur and lingering at a point only subjects the instrument to additional unnecessary metal fatigue.

Details of the lightspeed technique

Manufacturers of any rotary instruments modify their techniques from time to time, and clinicians frequently employ their own variations as well. Such modifications or "evolutionary" changes have occurred with LightSpeed as well. These changes indicate an increased confidence with the techniques; being able to modify the principles; adapting newer techniques to existing ones; and, most importantly, because the anatomy of root canals vary so widely. For the sake of completion, three methods of using LightSpeed instruments are described. The first is the Zurich LightSpeed technique [5–7], the second is the manufacturer's recommended LightSpeed technique [8,9], and the third is the manufacturer's recommended hybrid technique. Publications have already described how different tapered rotary systems can be combined [10] and LightSpeed can readily be combined with other tapered systems.

Zurich LightSpeed technique

Three special instruments should be singled out while using the Zurich LightSpeed technique. These are the "initial apical rotary" (IAR), the "master apical rotary" (MAR), and the "final rotary" (FR) [7]. The IAR is defined as the first LightSpeed instrument, which begins to cut canal walls at the working length, whereas the MAR is the last instrument to form the apical preparation. The MAR may be 6 to 12 LightSpeed sizes larger than the IAR. The FR is the last step-back instrument and completes the step-back procedure.

The Zurich LightSpeed technique is divided into four steps. Step 1 constitutes the access and coronal preflaring, step 2 determines working length and the IAR, step 3 determines the MAR, and step 4 completes the step-back and recapitulation.

Step 1: Access and coronal preflaring

After the canal orifices are located, their diameters are enlarged in a step-down or crown-down procedure using Gates-Glidden burs (GGBs; Dentsply Maillefer), progressing from large to small sizes [11,12]. In shorter canals, two GGBs may suffice; in longer canals, three or four GGBs may be indicated. Each GGB advances only 1 mm to 1.5 mm into the canal, enlarging no more than the coronal 4 mm to 6 mm. It is important to follow the root's long axis and oval canals can be milled readily with the GGBs. The step-down procedure or preflaring removes significant amounts of necrotic tissue and microorganisms from the canal coronally.

Step 2: Determine working length and IAR

After preflaring, the working lengths are determined for each canal using at least size 15 stainless steel K-Files; this is verified radiographically or electronically. LightSpeed instruments are used from this point on, beginning with size 20; the aim is to reach the working length. The first few LightSpeed instruments used may not ream the canal walls because the canals are too large; these instruments are termed "nonbinding" instruments. Nevertheless, always begin with size 20, sequentially progressing to larger sizes without skipping a single size. Nonbinding instruments advance in steps of 1 mm to 2 mm to the working length with slow, controlled movements. Eventually, one LightSpeed instrument will start to cut the canal walls at working length; this instrument is designated the IAR.

Step 3: Determine MAR

All LightSpeed instruments used after the IAR are called "binding instruments." They are used with controlled forward (1 mm to 2 mm) and backward (2 mm to 4 mm) "pecking" movements. The forward motion reams the canal, whereas the backward motion tends to clean the cutting head as it retreats into fresh irrigant. These instruments also are used sequentially from smaller to larger sizes, each advancing with the "pecking" movements. The diameter of the apical preparation increases with each instrument that reaches working length. The last instrument used to form the apical preparation is the MAR. The MAR may be 6 to 12 LightSpeed instruments larger than the IAR.

The exact position of the apical preparation in relation to the radiographic apex depends on the clinician's own philosophy and will vary from dentist to dentist. Likewise, the diameter of the final apical preparation also is controversial because it has been virtually ignored. For this reason, it has been called the "forgotten dimension" [9]. To ensure that the apical preparation has cleaned the canal, the preparation's final size must be larger than the canals preinstrumentation diameter. A review of the literature suggests the average sizes for MARs (Table 2) [9].

The size of the MAR can be modified and depends on several factors such as the degree and angle of curvature, presence of secondary or tertiary curves in the canal, thinner or wider root apices, and amount of canal obliteration. The MAR should be reduced when the degree and angle of curvature are large or when the root apex on radiograph is thin and pointed. In contrast, a broad apex calls for a larger MAR.

Step 4: Step-back and recapitulation

LightSpeed instruments are stepped-back after selecting the MAR. The working length for the first step-back instrument is 1 mm shorter than the canal's working length, and each subsequent step-back instrument is 1 mm shorter than the previous instrument. The number of step-back instruments will vary from canal to canal. The last step-back instrument is termed the FR and runs into the step-down or coronal preflaring previously prepared.

Table 2
Average sizes for MARs

Tooth	MAR size
Maxillary teeth	
Centrals	70
Laterals	60
Cuspids	60
1st premolars	60
2nd premolars	50
1st molar buccals	40
1st molar palatal	50
2nd molar buccals	40
2nd molar palatal	50
Mandibular teeth	
Centrals	60
Laterals	60
Cuspids	80
1st premolars	60
2nd premolars	50
1st molar mesial	40
1st molar distal	50
2nd molar mesial	40
2nd molar distal	50

Finally, all canals are recapitulated once with using their respective MARs to working length. Figs. 6 through 9 detail four molars that were endodontically treated by general practitioners using the Zurich LightSpeed technique.

The Zurich LightSpeed technique can be combined readily with currently marketed tapered rotary systems. This procedure calls for .04 or .06 tapered system to be used according to the manufacturer's instructions, but only until the size 20 instrument completes the crown-down mode. From this

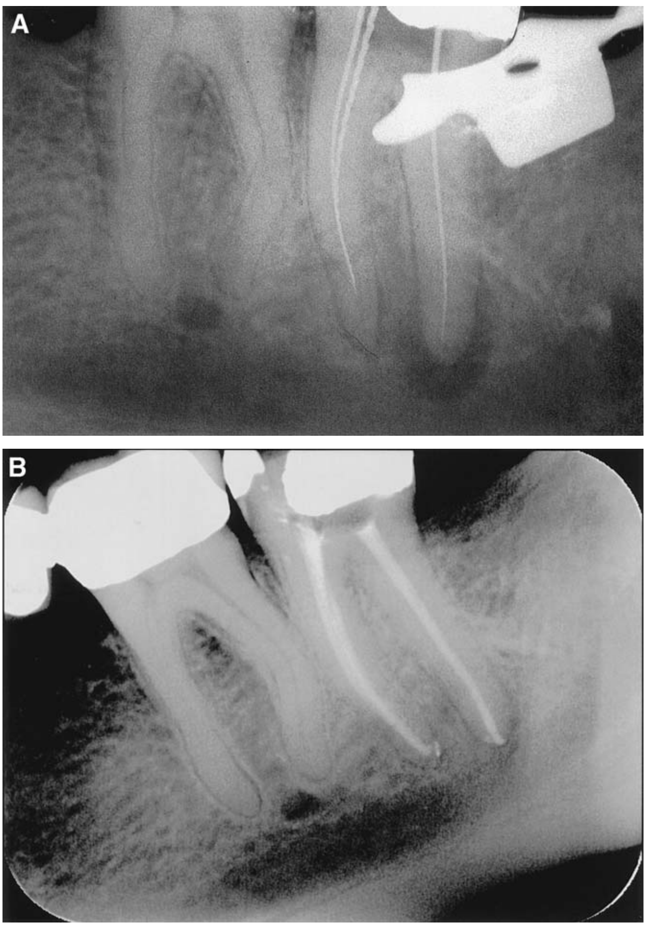


Fig. 6. (*A*) Working length radiograph of a mandibular second molar scheduled for LightSpeed preparation using the "Zurich technique" (February 11, 1997). Note the apical periodontitis on the mesial and distal root apices (case supplied by Dr. A. Bindl). (*B*) Final fill radiograph (lateral condensation) of the mandibular second molar (Fig. 6A) prepared with LightSpeed instruments (May 27, 1997). MAR in all canals was size 50. Both apical radiolucencies are resolving (case supplied by Dr. A. Bindl). (*C*) Thirty-month follow-up radiograph of the mandibular second molar shown in Fig. 6A with a Cerec (Sirona, Bensheim, Germany) restoration and healed apical areas (January 28, 2002; case supplied by Dr. A. Bindl).

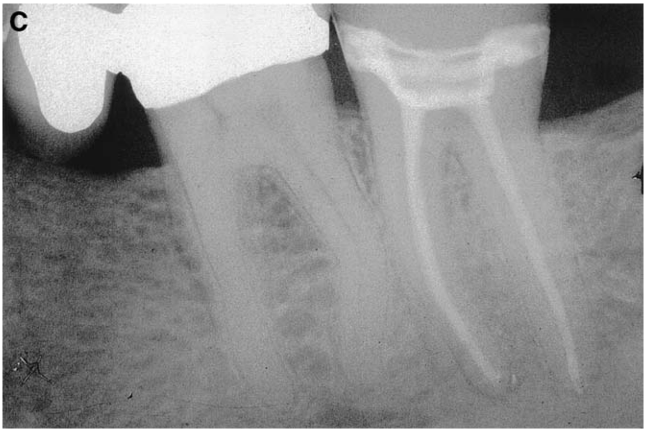


Fig. 6 (*continued*)

point, the apical and middle thirds of the canal (5 mm to 8 mm) are completed using LightSpeed instruments as described above.

Manufacturers recommended LightSpeed technique

The manufacturers recommended technique states that before beginning instrumentation with LightSpeed, a straightline access should be made, the canal should be flared coronally with any instrument such as GGBS (not LightSpeed), the working length should be determined, and canal patency should be achieved with at least a size 15 K-type file [13]. Pulp tissue should be removed with broaches when possible and then LightSpeed instruments are used to complete canal preparation in the five steps described below.

Step 1: Determine the LightSpeed size that is used to begin rotary instrumentation (sizing or gauging the apical canal diameter)

This step determines the smallest canal dimension from the canal orifice to the working length, and which LightSpeed instrument begins the instrumentation. The sizing process (gauging) avoids wasting time using LightSpeed instruments that are too small for the canal and provides valuable information about preinstrumentation canal size—information that is critical to prevent the underpreparation of canals.

To gauge (size) with LightSpeed instruments correctly they must be used by hand, advancing apically using moderate pressure but never rotated. The concept of gauging or sizing is as follows. A LightSpeed instrument can reach working length if its cutting head is smaller than the canal's diameter from orifice to working length. For example, a size 25 LightSpeed that goes to working length indicates that the canal's diameter is larger than the size 25 instrument. Gauging continues with sequentially larger sizes until a LightSpeed instrument does not go to working length. Continuing with

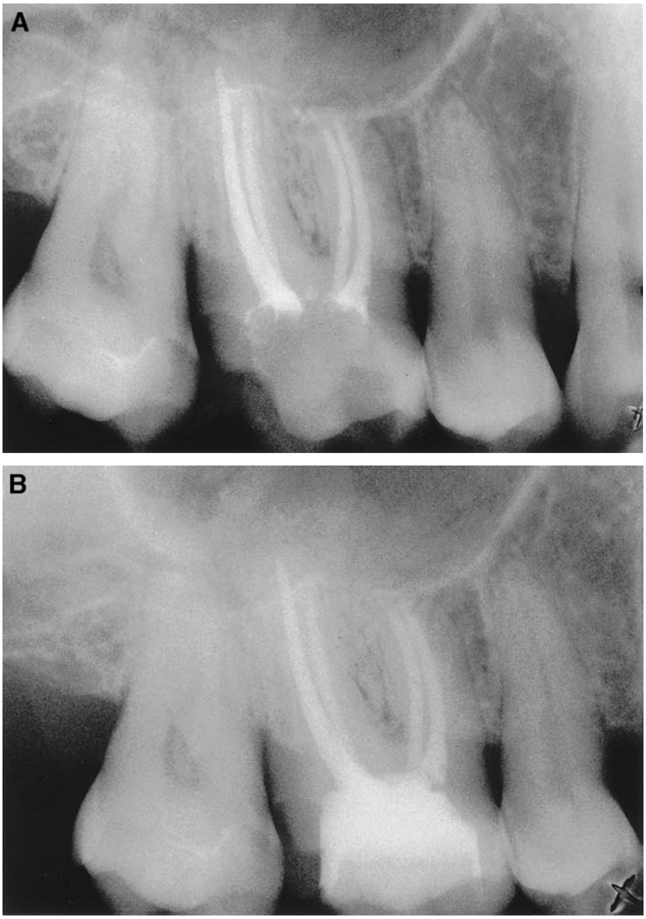


Fig. 7. (*A*) Radiograph of the final fill (lateral condensation) of four canals in a maxillary first molar prepared with LightSpeed instruments using the "Zurich technique" (December 12, 1996). MAR in the four canals was size 47.5 (case supplied by Dr. A. Bindl). (*B*) Five-year follow-up radiograph of the maxillary first molar shown in Fig. 7A (February 24, 2003). MAR in all four canals was size 47.5 (case supplied by Dr. A. Bindl).

the above example, if size 25 reaches working length but size 27.5 does not, then size 27.5 is called the First LightSpeed Size to Bind (FLSB). The FLSB is placed in the handpiece to begin rotary instrumentation.

Step 2: Determine the apical preparation size

Start instrumenting with the FLSB using a slow, continuous movement, advancing cautiously until it engages the canal walls. At this point, immediately stop advancing, pause for a fraction of a second, and then progress apically with an advance and withdrawal motion ("pecking"). This "pecking" movement translates into a downward cut of the dentin followed

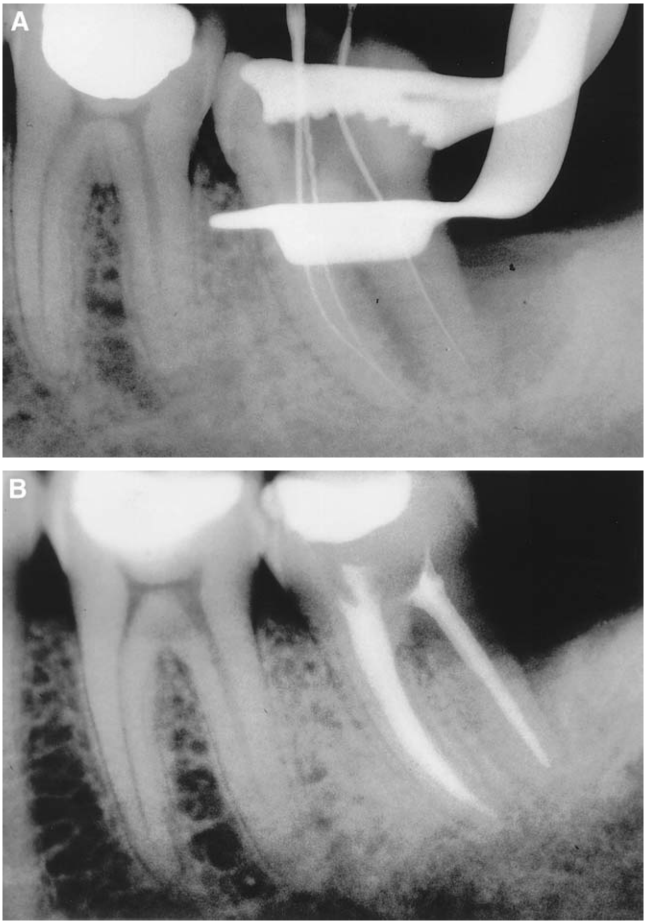


Fig. 8. (*A*) Working length radiograph of a mandibular second molar scheduled for preparation with LightSpeed instruments using the ‘‘Zurich technique’’ (November 1994). Note the endo-perio lesion adjacent to the distal root (case supplied by Dr. J. Zafran). (*B*) Eighteen-month follow-up radiograph of the mandibular second molar shown in Fig. 8A (April 1996) obturated with ThermaFil. MAR in the two mesial canals and one distal canal were sizes 42.5 and 50, respectively. Note the healed endo-perio lesion adjacent to the distal root (case supplied by Dr. J. Zafran).

by a slight withdrawal of about 1 to 3 mm. Count the number of pecks it takes the FLSB to reach working length, repeating the counting of pecks with each sequentially larger instrument. As the canal is cut rounder, the cutting head works harder because it is removing more dentin. The extra cutting effort requires more pecks to advance the instrument from when it starts cutting until it reaches working length.

After determining the FLSB, the appropriate size of the apical preparation to achieve the significant goal of apical cleaning is determined. The instrument that takes at least 12 pecks to reach working length is the

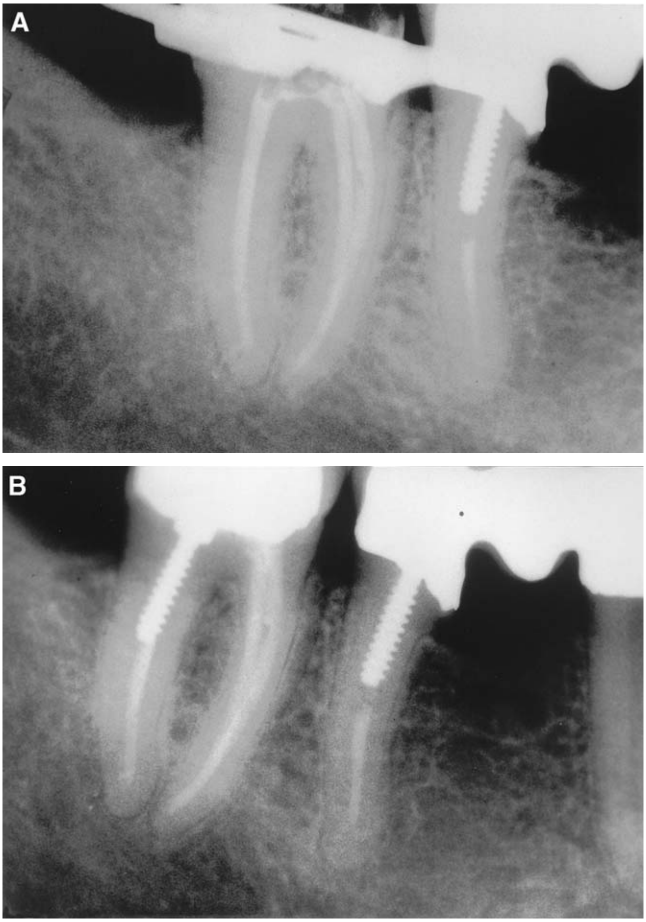


Fig. 9. (*A*) Final fill radiograph (ThermaFil) of a mandibular second molar prepared with LightSpeed instruments using the "Zurich technique" (November 1994). MAR in the two mesial canals and one distal canal were sizes 42.5 and 50, respectively (case supplied by Dr. J. Zafran). (*B*) Fifteen-month follow-up radiograph of the mandibular second molar shown in Fig. 9A (February 1996; case supplied by Dr. J. Zafran).

MAR. This is called the 12 "pecks" rule. Canals with naturally large or small sizes will have larger- or smaller-sized MARs, respectively. The size of the MAR depends on the preinstrumentation canal size, which varies from tooth to tooth. There is no such thing as a given canal size for each tooth in the mouth.

Step 3: Complete apical instrumentation

After determining the MAR size with the 12 "pecks" rule, complete the apical preparation by using the very next LightSpeed size that is 4 mm shorter than the working length. This enables the 5-mm long SimpliFill GP

Plug (LightSpeed Endodontics) to closely match the size and shape of the canal preparation. However, if obturating with standardized GP cones, step back 4 mm with sequentially larger LightSpeed instruments so that each length is 1 mm shorter than the previous instrument. This prepares the apical 5 mm of the canal with a taper matching that of a standardized cone.

Step 4: Instrument mid-root

If obturating with SimpliFill, continue instrumenting the middle 4 to 5 mm of the canal only with sequentially larger full size (skip half-sizes) LightSpeed instruments. Use the same "pecking" motion described in step 2 until a LightSpeed instrument no longer advances easily. Continue this process with sequentially larger LightSpeed full sizes until reaching a size that cannot advance easily past the apical extent of the coronal third of the canal. Do not allow any mid-root instrument to enter the apical 5 mm. However, if obturating with standardized GP cones, do not skip half-sizes during the mid-root preparation. Continue the step-back from working length in 1-mm increments until reaching a LightSpeed size that is at least 25 larger than the MAR. For example, if the MAR is a size 40, step back in 1-mm increments to at least a size 65.

Step 5: Recapitulate

Recapitulate to the working length of each canal with the respective MAR. The MAR is the instrument that required at least 12 "pecks" to reach working length (step 2).

LightSpeed technique combined with taper technique

LightSpeed Endodontics recommends this hybrid technique for clinicians wishing to combine both tapered rotary and LightSpeed systems. In this way, canals can be cleaned and shaped in a crown-down fashion according to the technique recommended by the manufacturer of the tapered instruments used. After the crown-down is completed, LightSpeed instruments complete the apical part of the canal [8]. The hybrid technique assumes that the canal has first been instrumented to working length with .04 or .06 tapered rotary instruments with a tip size 25 using the manufacturer's recommended technique. Then, LightSpeed instruments are used to complete the apical preparation.

Step 1: Apical gauging

Follow the concept of apical gauging described in step 2 of the manufacturers recommended LightSpeed technique. With the combined technique, always start the gauging process by hand with a size 35 LightSpeed instrument, without rotating it and using moderate force. After entering the canal, advance the instrument apically and one of three things will occur:

A. If the size 35 instrument reaches working length without binding, continue gauging with sequentially larger LightSpeed instruments until one binds before the working length (as explained previously, this instrument is called the FLSB). Then proceed to step 2.
B. However, if the size 35 instrument does not reach working length but binds 3 mm (or less) short of the working length, then it also is called the FLSB. Proceed to step 2.
C. If the size 35 LightSpeed instrument binds more than 3 mm short of the working length, it means that the apical part of the canal is not ready to be mechanically prepared with LightSpeed instruments. Reconfirm that the tapered preparation was performed correctly. If confirmed to be correct and the size 35 gauging instrument still does not bind within 3 mm of working length, then file the canal with K-files until a size 35 LightSpeed instrument reaches working length. Proceed to step 2.

Step 2: Begin LightSpeed rotary preparation

Place the FLSB determined in steps 1A or 1B in the handpiece and begin instrumentation using the same hand motions and following the exact technique described in step 2 of the manufacturers recommended LightSpeed technique. The apical preparation is complete when the canal is instrumented to the MAR using the 12 "pecks" rule.

Discussion

This article discusses three ways to use LightSpeed instruments. Purists may contend that the manufacturer's recommended technique always should be followed to the letter. Although some clinicians may do just that, others modify the methods that they have learned at courses on LightSpeed or other nickel-titanium rotary techniques. Consequently, two of the three techniques in this article describe using LightSpeed instruments alone and one describes the combined use of LightSpeed with tapered rotary instruments. Although using two rotary techniques has advantages, some clinicians complain about combining two systems and the related increased costs. Nevertheless, the three techniques are described to give experienced and nonexperienced users pointers on how LightSpeed instruments may be used.

Generally, LightSpeed instruments enable larger apical preparations because their design maximizes the flexibility of nickel-titanium more so than do other rotary instruments currently available, particularly for the larger sizes. Independent studies performed since 1995 [14–21] indicate that LightSpeed instruments produce better-centered apical preparations compared with other files or instruments. For example, apical preparations in mesial canals of mandibular molars produced little or no apical transportation when prepared by LightSpeed instruments [14], even when canals were prepared using size 50 LightSpeed instruments [17]. Although apical preparations can be made to larger sizes, coronal thirds are not over-instrumented because of the unique design of LightSpeed instruments. On the other hand, microcomputer tomography [22] showed that up to 40% of root canal walls remained uninstrumented when shaped by different rotary techniques or manually [23].

The logical question is "are larger apical preparations necessary"? Recent studies [24–27] indicate that larger apical preparations removed more infected tissue and bacteria. Furthermore, larger apical preparations create more space for larger amounts of irrigants to ensure a more effective disinfection [28]. Detailed anatomy of apical constrictions [29] and mean diameters of root canals near the apical foramina [30–33] suggest that larger preparations are necessary to optimize the cleaning procedure. To highlight this point, 95% of molar mesial canals require shaping to at least a size 60 to adequately instrument the apical 1 mm [32].

To summarize, it is well established that bacteria in root canals are endodontists' main problems and if larger apical preparations reduce bacterial counts, then it is logical to conclude that larger apical preparations may yield better outcomes. However, despite an electronic scan of the literature, no publications were found linking better clinical outcomes to larger-sized apical preparations. Nevertheless, if the chemomechanical removal of microorganisms is the goal in endodontics, an apical preparation larger than the uninstrumented canal size must be the aim of any root canal preparation.

Instrument maintenance and replacement

Concepts must be in place so that chairside assistants know how frequently rotary instruments have been used clinically. LightSpeed instruments are too expensive to be used only once, but cyclic and torsional fatigue may cause instruments to fracture if they are used too frequently. Consequently, the manufacturer recommends using the smaller LightSpeed sizes (20–47.5) for up to 8 cases and the larger sizes (50 and above) for up to 16 cases. They suggest that each tooth with normal canal curvatures, including molars, be considered a case (Steve Senia, DDS, San Antonio, Texas, personal communication, July 2003). Instruments should be replaced after a single use when the degrees of curvature are excessive or abrupt (short radius) curvatures are present.

After usage, LightSpeed instruments should be ultrasonicated in tap water for a few minutes in small portable devices to remove any biologic material lodged within the cutting flutes. The instruments then can be sorted, placed in the special LightSpeed Organizer (LightSpeed Endodontics), and sterilized in the usual manner. Wear of LightSpeed cutting heads includes microfractures, disruption, metal strips, and pitting or fretting (Figs. 10, 11); minor imperfections also were found on new instruments

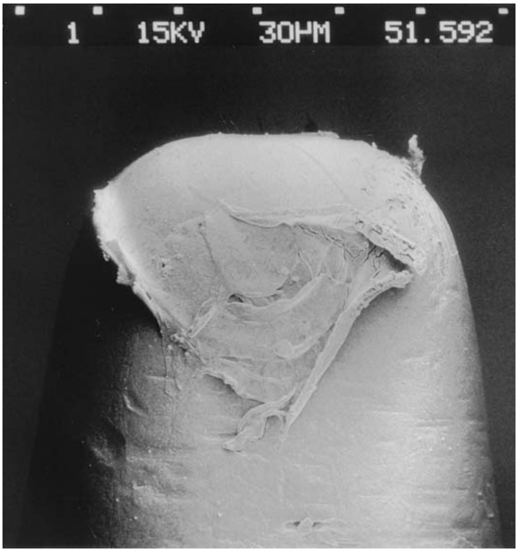


Fig. 10. Photomicrograph (original magnification ×215) showing metal strip on the noncutting pilot tip of a size 37.5 LightSpeed instrument used clinically in 20 canals. (*Modified from* Marending M, Lutz F, Barbakow F. Scanning electron microscope appearance of Lightspeed instruments used clinically: a pilot study. Int Endod J 1998;31(1):60; with permission.)

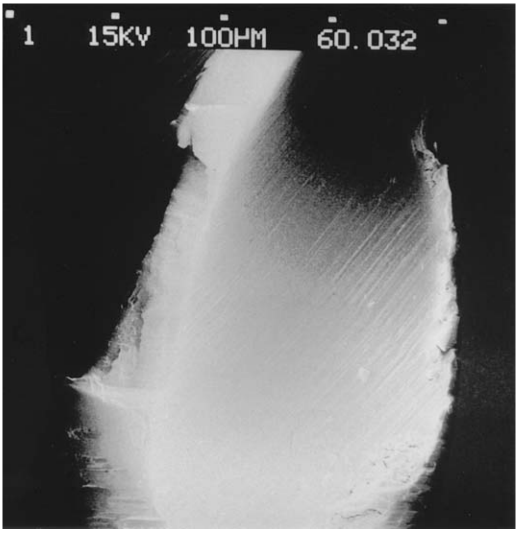


Fig. 11. Photomicrograph (original magnification ×90) of a disrupted edge and metal flash of radial lands of a size 50 LightSpeed instrument used clinically in 20 canals. (*Modified from* Marending M, Lutz F, Barbakow F. Scanning electron microscope appearance of Lightspeed instruments used clinically: a pilot study. Int Endod J 1998;31(1):60; with permission.)

[34,35]. It would be interesting to compare the wear of LightSpeed instruments to the wear of other nickel-titanium rotary instruments. Minor imperfections in unused LightSpeed instruments show how difficult it is to machine such delicate nickel-titanium instruments.

Instrument fracture

Any rotary instrument can fracture, particularly in curved canals when the manufacturer's basic guidelines are ignored. When used properly, LightSpeed instruments are not prone to fracture but when they do, fractures may occur at two sites. One is at the shaft–shank junction and is due to excessive angulation of the instrument in the canal orifice combined with poor access or unintended tipping of the handpiece by the clinician (Fig. 12A, B). Such fractured instruments are removed readily from the root canals. The second site for fracture is a few millimeters from the cutting head and generally is caused by excessive feed (locking the cutting head in the canal) or excessive speed, which accelerates metal fatigue. Such fractured segments are more difficult to remove (Fig. 13A–C). They may be bypassed, or left in situ and integrated in the oburation. The latter is indicated when larger instruments are involved and the greater part of the canal has been cleaned and well irrigated.

Explain any mishap to the patient, informing him or her of the pros and cons involved in any subsequent therapy. Also tell the patient how important regular follow-ups are to determine the treatment's outcome. Instrument fracture is a real concern for clinicians, but practicing the technique diligently and being aware of the important do's and don'ts pertinent to the LightSpeed technique can significantly reduce the incidence of fracture. Box 1 summarizes the more important do's and don'ts pertinent to the innovative LightSpeed technique. LightSpeed instruments are fascinating, innovative, and maximize the flexibility of nickel-titanium. Just as with any new technique, the LightSpeed methods should be mastered before using them on patients, beginning with simpler canals and then progressing to more challenging cases.

Summary

LightSpeed instruments, with their short cutting heads, noncutting pilot tips, and long thin taperless shafts, are unique in their design. The instruments maximize the flexibility of nickel-titanium, particularly for the larger sizes. Consequently, they enable larger apical preparations without overpreparing the coronal canal thirds. By so doing, better mechanical removal of necrotic debris and microorganisms may be possible. With larger canal spaces, more disinfecting irrigants can reach the apical areas and may ensure a better disinfection.

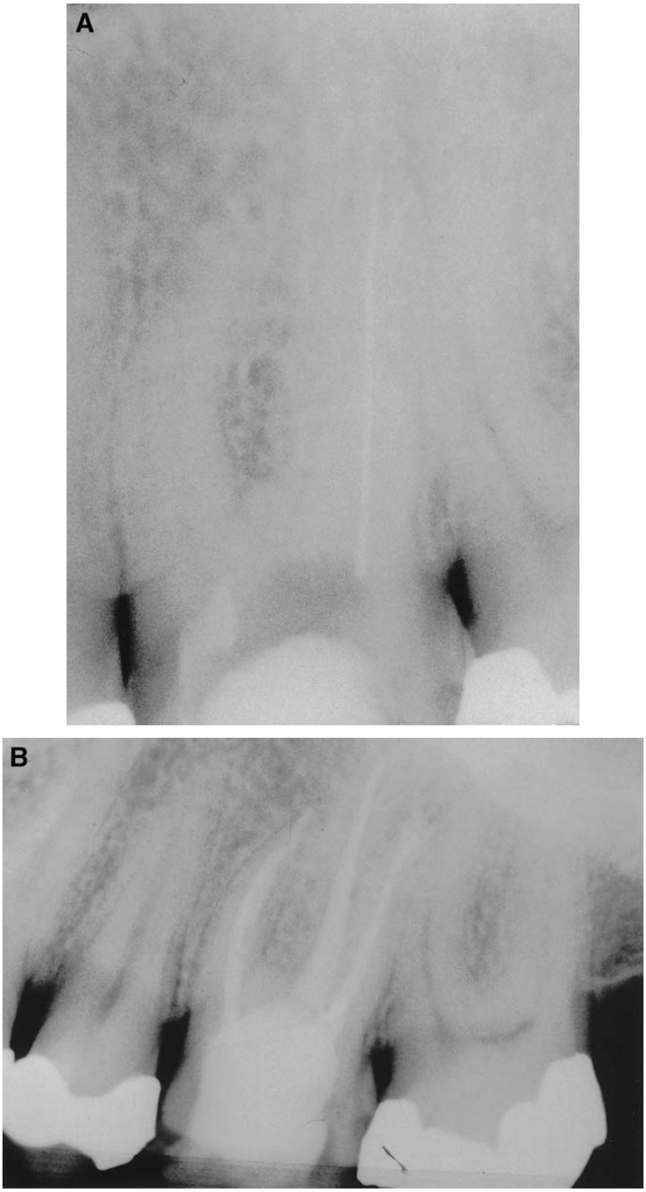
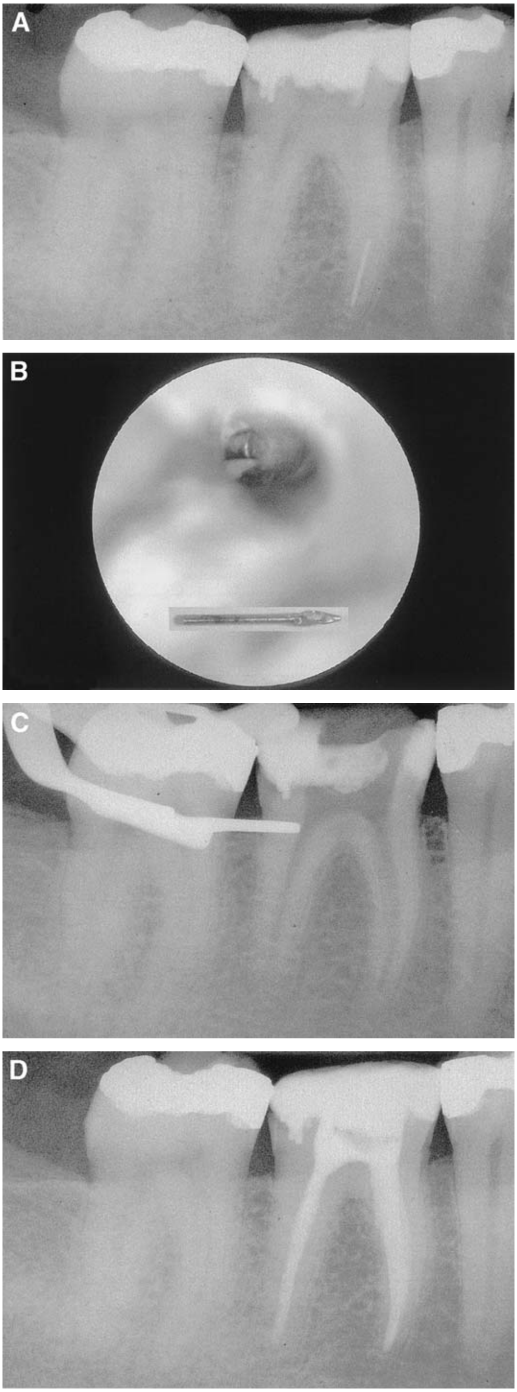


Fig. 12. (*A*) Radiograph showing a fracture in the "shaft-shank area" of a LightSpeed instrument in the disto-buccal canal of a maxillary first molar (case supplied by Dr. N. Gabutti). (*B*) Final fill radiograph of the tooth shown in Fig. 12A following removal of the fractured LightSpeed segment from the disto-buccal canal (case supplied by Dr. N. Gabutti).


A
B
C
D

Box 1. Summary of do's and don'ts when using LightSpeed instruments

Do's	*Don'ts*
1. Use a light touch at all times for all sizes	1. Don't force LightSpeed instruments
2. Always irrigate canals before using LightSpeed instruments	2. Don't use LightSpeed instruments in dry canals
3. Maintain a reservoir of irrigant in the pulp chamber	3. Don't exceed a speed of 2000 rpm
4. Control the forward and backward motions when carrying out the ''pecking''	4. Don't linger at a point when the working length has been reached
5. Reduce the feed distance when resistance is felt	5. Don't vary the speed while instruments are rotating in the canal
6. Maintain a constant speed	6. Don't use LightSpeed without rubber dam
7. Ensure that the instrument continuously rotates while in the canals	7. Don't overuse LightSpeed instruments
8. Never skip an instrument size to try and gain time	
9. Always concentrate when using LightSpeed instruments	
10. Replace instruments at regular intervals	

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Fig. 13. (*A*) Radiograph showing a fractured LightSpeed instrument in a mesial canal of a mandibular second molar (case supplied by Dr. P. Velvart). (*B*) View of the fractured surface of a LightSpeed shaft seen through an operating microscope and the retrieved instrument after removal using ultrasonics (case supplied by Dr. P. Velvart). (*C*) Radiograph confirming retrieval of the fractured LightSpeed segment shown in Fig. 13A (case supplied by Dr. P. Velvart). (*D*) Final fill radiograph after retrieving the fractured segment shown in Fig. 13A (case supplied by Dr. P. Velvart).

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