ELECTRIC HANDPIECE SYSTEMS

When collecting preliminary information about electric handpiece systems, we found that of the 146 dentists who responded to a survey, 67 percent did not own an electric handpiece but 45 percent planned to purchase one.

An electric handpiece system consists of a control box, tubing, electric motor, and various attachments for high- and low-speed applications. One motor can be used with both high- and low-speed handpiece attachments, and in most cases, the control box easily installs into existing dental units and is air-activated with compressed air.

Limited published information exists on the performance of these systems; however, one study has reported higher cutting efficiency using electric systems when compared to air-driven handpieces.[1] Unlike air-turbine handpieces, electric handpieces are equipped with a control system that allows them to maintain speed as the load on the bur increases (See p 9), which contributes to cutting efficiency. We tested eight electric handpiece systems in the ADA Laboratory to see how well they maintained speed as torque increased.

While improved cutting efficiency is a significant advantage, concerns exist about pulpal temperature increase due to higher cutting rates. A report by the U.S. Army Dental Research Detachment concluded that despite the higher cutting efficiency of the electric handpiece, the temperature of the pulp chamber did not increase any more than when a conventional high-speed handpiece was used.[2] Watson et al. likewise reported that, although differences exist between the two systems with respect to power and pressure applied when cutting, the electric handpieces were not associated with an increase in pulpal temperature changes or sub-surface enamel cracking when compared against air-turbine handpieces.[3]

Although pulpal temperature does not seem to be affected by these handpieces, the tip of the handpiece itself can become hot if the unit is not properly maintained. The U.S. Food & Drug Administration has received several reports of patient burns that appear to have been caused by overheated handpieces (See box).

Maintaining high torque while cutting produces a marked change in the "feel" while cutting,[1] leading to a learning curve before one can use these instruments effectively. In addition, these units are heavier than conventional air-rotors, and operator fatigue due to weight and balance of the motor component plays an important role in buying decisions. Among practitioners we surveyed, 25 to 50 percent rated the overall ergonomics of the electric handpieces as "fair" or worse. We encourage you to handle several brands to find one that feels comfortable.

In addition to the ergonomic issues, cost was cited as a drawback by some of the dentists we surveyed. However, advantages such as versatility of using different attachments with the same system help create a single system for low- and high-speed applications. Precise cutting and lower noise levels are thought to be other attributes to these systems.[4] In our survey, practitioners listed power, ergonomic design and comfort, product reliability and noise level as the main features that should drive purchasing decisions.

Editor's Note: We are testing high-speed air-turbine handpieces for a future ADA Professional Product Review. In that report, we'll look at high-speed and electric handpiece features and performance.

Severe burns associated with inadequate maintenance

The U.S. Food & Drug Administration has received reports of severe burns caused by pneumatic and electric micromotor handpieces. In a majority of cases, burns were caused by overheating of various handpiece components. In these events, overheating was due to failure to service and maintain the handpieces in accordance with the manufacturer's recommendations.

"While any handpiece can overheat," says Dr. Janie Fuller, an analyst in the device surveillance office at FDA, "it appears that when electric handpiece systems aren't well-maintained, the handpiece head can overheat very rapidly. The overheating can cause third degree burns before the user realizes there's a problem."

Dr. Fuller emphasizes that electric handpieces are reported to become dangerously hot in a matter of seconds, without any warning to the user.

"Air-driven handpieces begin to feel and sound differently when the gears are worn or they need maintenance," explains Dr. Fuller, "but electric handpieces don't bog down like air-driven handpieces. Instead, the electric micromotor sends more power to the worn gears and friction in the gears and/or the bearing assemblies transfers into heat."

Among the incidents FDA has investigated to date, the users had not followed the handpiece manufacturer's recommended maintenance schedule. Additional data that the FDA has obtained from manufacturers' representatives suggest that similar overheating can result from improper use conditions (for example, running the 1:5 handpiece as a "low-speed" instead of switching to a prophy attachment).

"We are studying the issue and may provide some additional guidance to users in the future," says Dr. Fuller. For now, to reduce the risk of burns, FDA urges you to strictly adhere to the manufacturer's instructions for use, maintenance, servicing and lubrication.

If you experience overheating of an electric handpiece, or have any other adverse experience with any dental equipment or material, contact the FDA's MedWatch program. Information about MedWatch is available online (www.fda.gov/medwatch/how) or by phone (1-800-FDA-1088).

1.Eikenberg S. Comparison of the cutting efficiencies of electric motor and air turbine dental handpieces. Gen Dent 2001;49(2):199-204.
2.Eikenberg S, Roman D, Debuque R, Gerrono D, Harris E. Protocol 451: Development of lightweight, low cube, portable dental field equipment. http://hayeshandpiece.com/Army_Study_On_Electric_Handpieces.pdf. Accessed Oct. 27, 2006.
3.Watson TF, Flanagan D, Stone DG. High and low torque handpieces: cutting dynamics, enamel cracking and tooth temperature. Br Dent J 2000;188(12):680-6.
4.Dentistry Today 25(4) April 2006.

Apex Lares Research 800-347-3289 www.laresdental.com	**ELECTROtorque plus** KaVo 800-323-8029 www.kavousa.com	**Midwest eStylus** DENTSPLY Professional 800-989-8825 www.dentsply.com	**Ti-Max NL400** Brasseler USA/NSK 800-841-4522 www.brasselerusa.com
EA-40LT A-dec 800-547-1883 www.a-dec.com	**Micromotor MX Series** Bien-Air 800-433-2436 www.bienair.com	**SIROTorque L+** Sirona Dental Systems 800-659-5977 www.sirona.com	**Titan E-lectric** DentalEZ Group/Star 866-DTEINFO www.dentalez.com

Product Review

For this review, we evaluated eight brands of electric handpieces: Apex (Lares Research), EA-40LT (A-dec), ELECTROtorque plus (KaVo), Micromotor MX Series (Bien-Air), Midwest eStylus (DENTSPLY Professional), SIROTorque L+ (Sirona Dental Systems), Ti-Max NL400 (Brasseler USA/NSK) and Titan E-lectric (DentalEZ Group/Star) (Table 1). Notice that some systems have brush motors and other have brushless motors (See "Brush versus Brushless Motors).

We tested three handpieces of each brand in the ADA laboratories to document size and performance. We also received 253 survey responses from dentists about these products.

Table 1. **Electric Handpiece System Features According to the Manufacturer.**

Product (Manufacturer)	**Brush vs. Brushless Motor**	**Maximum Motor Torque - Ncm**	**Motor Speed Range - rpm**	**Head Design Variations**	**Available Gear Ratios** (Contra Angles)		**Sterilizable Motor**
					High Speed	Low Speed	
Apex (Lares Research)	Brush	2.8	0-40,000	One size	1:5	1:1, 4:1	Autoclavable removable sleeve
EA-40LT (A-dec)	Brushless	4	2,000-40,000	One size	1:5	1:1, 1.5:1, 2:1, 10:1, 128:1	Yes
ELECTROtorque plus (KaVo)	Brushess (5th generation)	3	2,000-40,000	Small, Standard	1:5, 1:3	1:1, 2:1, 2.7:1 3:1, 7.4:1, 10:1	Yes
Micromotor MX Series (Bien-Air)	Brushless	6	100-40,000	Small, Medium	1:5	100:1, 30:1, 10:1, 1:1	Yes
Midwest eStylus (DENTSPLY Professional)	Brush	2.6	1,500-40,000	Standard	1:5	1:1, 10:1	Autoclavable removable sleeve
SIROTorque L+ (Sirona Dental Systems)	Brushless	2.4	90-40,000	Mini, Standard	1:5	1:1, 6:1, 24:1 9.5:1, 2.4:1	No
Ti-Max NL400 (Brasseler USA/NSK)	Brushless	3.0	2,000-40,000	Mini (1:5 only) Standard	1:5	1:1, 4:1, 10:1, 16:1, 64:1, 128:1	Yes
Titan E-lectric (DentalEZ Group/Star)	Brush	3.0	100-200,000	Mini, Standard, Straight	1:5*	1:1*†, 16:1†	No

* With friction grip chuck models.
† With latch-type chuck models.

Lab Notes:

Each manufacturer provided us with the motor, control box, couplers and tubing associated with their systems, three 1:1 contra-angle attachments, three 1:5 contra-angle attachments, and one 1:1 straight attachment (NOTE: The Apex system does not have a straight attachment. Per the Apex manufacturer's recommendation, we used the ELECTROtorque plus straight attachment). Testing in the ADA laboratories documented run-out, weight, dimensions, visibility angle, noise levels, light intensity, speed, and torque. After the tests were completed, we returned all of the equipment to the manufacturers. A full description of our test methods can be found on the ADA's web site at "www.ada.org/goto/ppr".

Brush vs. Brushless Motors

An important engineering improvement in electric handpieces is the development of brushless motors. A conventional brush motor has carbon brushes that transmit the electricity onto the rotor to make it turn. Carbon brushes wear down over time and need to be replaced. The brushes also produce carbon dust that needs to be cleaned out of the motor. A brushless motor, which employs a magnetic field, works without carbon brushes.

As an additional advantage, some brushless motors can be autoclaved depending on the material used in fabrication. Non-autoclavable motors often have an outer sleeve that can be removed and heat sterilized.

Basic Tests

We typically conduct a set of Basic Tests, which products can either pass or fail. These tests challenge a product's actual performance against a recommended standard, like those developed by the American National Standards Institute (ANSI).

For the electric handpieces, the only Basic Test was run-out. We tested the eccentricity of the handpieces with a standard mandrel in them and recorded the total indicated run-out, which provides a measure of how much the axis of the mandrel deviates from its geometric center at any given time during a complete revolution. The result gives an indication of the maximum deviation from the exact size of the hole that would be expected with the selected bur size/handpiece combination.

Weight, Dimensions, Visibility Angle

Clinical Significance: We weighed each product with the 1:1 and 1:5 contra-angle attachments in place because weight can contribute to operator fatigue. We also measured each product (head height and diameter, and the length of the handpiece with both attachments) to provide a sense of how easily you could access areas in the mouth. Finally, we checked the angle of the head to the long axis of the handpiece, which suggests how well you should be able to see the working tip during use.

Results: With either attachment in place, SIROTorque L+ had the lowest measurements, which generally allow for better intraoral access and visibility (Table 2).

Table 2. **Weight, Dimensions and Visibility Angle of Electric Handpieces with Attachments.**

Product (Manufacturer)	Weight - g		Dimensions - mm Head height (head + bur) x Head diameter x Length (motor + attachment)		Visibility Angle*	
	1:1 Attachment	1:5 Attachment	1:1 Attachment	1:5 Attachment	1:1 Attachment	1:5 Attachment
Apex (Lares Research)	202	210	16 x 10 x 194	16 x 10 x 194	12°	18°
EA-40LT (A-dec)	190	206	14 x 10 x 188	16 x 10 x 189	13°	21°
ELECTROtorque plus (KaVo)	208	206	15 x 11 x 198	16 x 11 x 201	20°	22°
Micromotor MX Series (Bien-Air)	232	235	15 x 10 x 190	16 x 10 x 190	16°	22°
Midwest eStylus (DENTSPLY Professional)	218	224	15 x 10 x 189	16 x 10 x 190	16°	22°
SIROTorque L+ (Sirona Dental Systems)	158	159	13 x 9 x 156	14 x 9 x 156	11°	17°
Ti-Max NL400 (Brasseler USA/NSK)	164	162	14 x 10 x 180	15 x 10 x 180	12°	19°
Titan E-lectric (DentalEZ Group/Star)	198	197	15 x 10 x 207	15 x 10 x 207	18°	18°

* Angualtion of the head to the long axis of the handpiece.

Reader Tip: Handling different brands will help determine which feels best in your hand, but generally, lower values for each of these features will allow for better intraoral access and visibility.

Noise Level

Clinical Significance: We measured the volume (amplitude of sound waves) of each brand, with attachments in place, at various pitches (sound wave frequencies) to confirm that the handpieces met Occupational Safety and Health Administration (OSHA) requirements.[2]

Results: All of the systems performed within the levels allowed by OSHA. Statistical analysis indicates that there was no difference between the volume levels recorded for these products (Figures 1 and 2).

Comments: These levels were measured when running the handpiece without applying any load. Noise levels during clinical use may vary from our results. Although there was no statistical difference between the products for volume, the relationship of pitch-to-volume varied between the brands. As such, you might consider your ability to tolerate certain pitches at certain volumes.

Figure 1. **Volume (Amplitude) at Various Pitches (Frequencies) for Electric Handpieces with 1:1 Attachment (45º).**

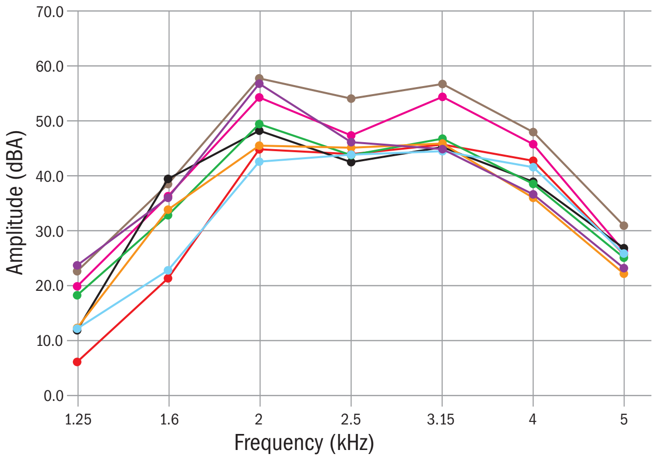
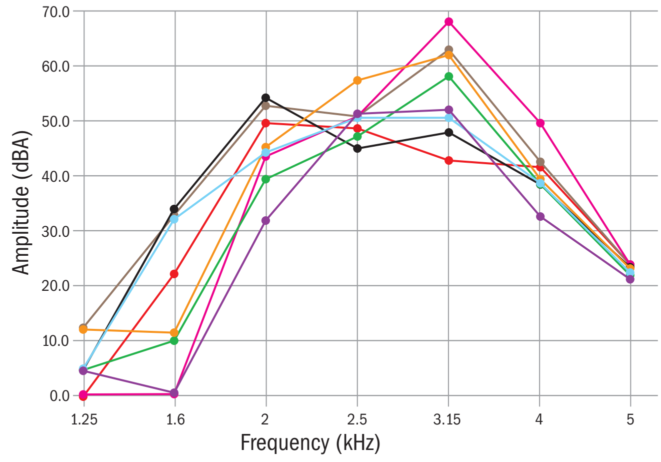


Figure 2. **Volume (Amplitude) at Various Pitches (Frequencies) for Electric Handpieces with 1:5 Attachment (45º).**



Apex · Midwest eStylus · EA-40LT · SIROTorque L+ · ELECTROtorque plus · Ti-Max NL400 · Micromotor MX Series · Titan E-lectric

Reader Tip: Although there was no statistical difference between the products for volume, the relationship of pitch-to-volume varied between brands. As such, you might want to try a few brands to determine whether you are comfortable with their respective noise levels.

Light Transmission

Clinical Significance: Each of these handpieces is equipped with a light source to help you see the working field during use. This test measured the intensity of the emitted light.

Results: We found a range of light intensities, with statistical analysis indicating similar performance between many of the brands (Table 3).

Comment: While an integrated light source may be helpful, other lighting-related factors, such as the operatory lighting, also will influence visibility of your working field. Also, repeated sterilization of the handpiece might affect light transmission over time.

Table 3. **Intensity of Integrated Light Source on Electric Handpieces with Attachments.**

Product (Manufacturer)	Mean Light Transmission* W/cm² (± SD)	
	1:1 Attachment†	1:5 Attachment†
Apex (Lares Research)	0.99 (± 0.11) [a]	0.85 (± 0.23) [c]
EA-40LT (A-dec)	0.87 (± 0.40) [a]	1.05 (± 0.35) [c]
ELECTROtorque plus (KaVo)	1.78 (± 0.06) [a,b]	1.94 (± 0.37) [c,d]
Micromotor MX Series (Bien-Air)	2.06 (± 0.52) [b]	1.85 (± 0.20) [c,d]
Midwest eStylus‡ (DENTSPLY Professional)	1.59 (± 0.58) [a,b]	1.77 (± 0.44) [c,d]
SIROTorque L+ (Sirona Dental Systems)	1.00 (± 0.11) [a]	1.40 (± 0.68) [c,d]
Ti-Max NL400 (Brasseler USA/NSK)	2.03 (± 0.38) [b]	2.31 (± 0.20) [d]
Titan E-lectric (DentalEZ Group/Star)	1.58 (± 0.18) [a,b]	1.65 (± 0.53) [c,d]

* Mean based on light intensity measured from three handpieces for each brand (n=3).
† Superscript letters indicate similar performance according to statistical analysis (one-way ANOVA, $p < 0.05$).
‡ Midwest eStylus has an adjustable light intensity setting (700-760 mA); we used the default setting of 730 mA.

Reader Tip: While an integrated light source may be helpful, other lighting-related factors, such as the lighting in the operatory, also will influence the visibility of your working field. Also, handpiece light intensity may be affected by repeated sterilization cycles.

Speed

Clinical Significance: One of the advantages of electric handpieces is that they maintain a consistent speed. This test determined whether the handpiece, running with attachments, achieved the speed set at the control box.

Results: With the 1:1 attachment, all of the handpieces were within 10 percent of the speed set on the control box except the Apex, which performed at 68 percent of the target. With the 1:5 attachment, all of the handpieces were within 10 percent of the set speed except Apex, which performed at 73 percent of the target, and SIROTorque L+, which performed at 63 percent of the target (Table 4).

Table 4. **Speed of Electric Handpieces with Attachments at a Control Box Setting.**

Product (Manufacturer)	Mean Speed* rpm	
	1:1 Attachment	1:5 Attachment
Control Box Setting	**40,000**	**40,000†**
Apex (Lares Research)	27,000	146,000
EA-40LT (A-dec)	38,000	207,000
ELECTROtorque plus (KaVo)	37,000	195,000
Micromotor MX Series (Bien-Air)	40,000	200,000
Midwest eStylus (DENTSPLY Professional)	38,000	201,000
SIROTorque L+ (Sirona Dental Systems)	36,000	127,000
Ti-Max NL400 (Brasseler USA/NSK)	37,000	191,000
Titan E-lectric (DentalEZ Group/Star)	36,000	188,000

* Mean based on n=9 runs.
† Expected bur speed would be 200,000 rpm.

Reader Tip: Both the Apex and the SIROTorque L+ performed below the Control Box setting when used with the 1:5 attachment. The Apex also fell below the target speed with the 1:1 attachment.

Testing Torque vs. Speed

With an air-turbine handpiece, rotational speed is dependant on air pressure and is rapidly reduced by any increase in resistance. As commonly experienced in dental practice, this drop in speed reduces cutting efficiency since there is no system in place to compensate for the resistance by supplying more power. Electric handpieces, however, are equipped with a feedback system to prevent the bur from slowing as you apply load (when cutting a tooth, for example). This concept is similar to the cruise control system in a car. When your cruise control is set and you start up an incline, the feedback systems kicks in to help you maintain that set speed.

Since this ability to maintain speed as load increases is purported to be a key feature of electric handpieces, we tested this claim in the ADA Laboratories.

Clinical Significance: This test documents the rotating speed of the bur as torque (think in terms of load) increases. It also gives you a sense of how smoothly the feedback system adjusts the speed as torque increases.

Basic Methods: We coupled an electric handpiece fitted with a straight attachment to a dynamometer, and set the electric handpiece to run at 20,000 rpm. Using the dynamometer, we serially increased the torque. A complete description of our test methods is available at "www.ada.org/goto/ppr".

Limitation: We were unable to test the handpieces at higher speeds because the dynamometers that are currently marketed accommodate a maximum speed of around 20,000 rpm.

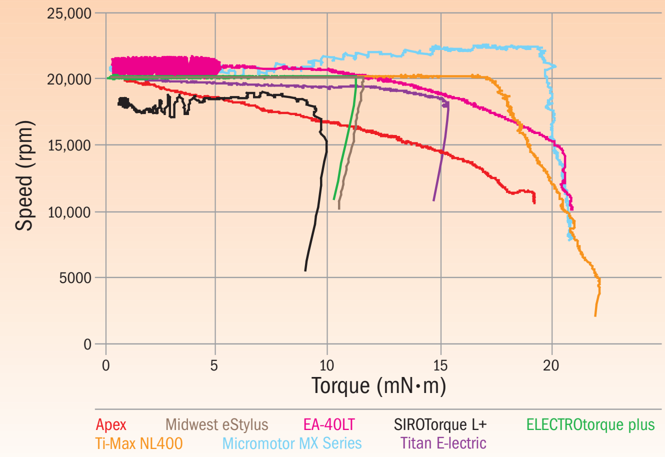
Continued on next page

Testing Torque vs. Speed continued

Comment: As Figure 3 shows, you can't increase torque indefinitely and expect the speed to remain constant. Eventually, one of two things will happen: the control system shuts off the motor (ELECTROtorque plus, Micromotor MX series, SIROtorque L+ and Titan E-lectric) or the control system becomes overwhelmed and no longer maintains speed (Apex, EA-40LT, Midwest eStylus and Ti-Max NL 400).

Results: As Figure 3 shows, only some systems maintained the speed set at the control box as torque increased. Apex did not maintain speed during the test. Although SIROtorque L+ never achieved the desired speed (20,000 rpm), its control system did try to maintain speed as torque increased until it shut down the motor at just below 10 milliNewton meters (mN•m). All of the other systems held their speed with increasing torque. To get the most out of this information, consider what types of loads you will be generating clinically. If you will rely on your handpiece for removing porcelain-fused-to-metal crowns, for example, you would want a system that can maintain a set speed at higher torque levels. The graph also illustrates how smoothly the systems adjusted their speeds to compensate for increasing torque. For example, the speeds of the EA-40LT and SIROtorque L+ fluctuated quite a bit as the torque initially increased.

Figure 3. **Speed vs. Torque for Electric Handpiece Motors.**



Reader Tip: Depending on how you will use your handpiece clinically, a motor that can generate a higher torque value without losing speed is preferred.

Practitioner Input

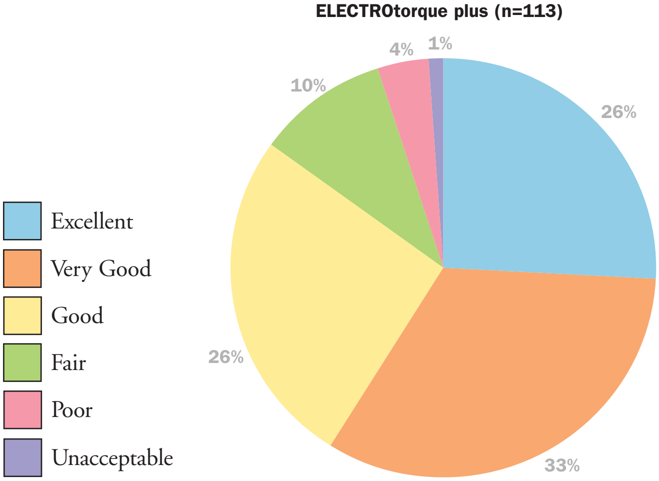
Through a Web-based survey, we received 253 responses about dentists' experiences with the electric handpieces featured in this review. Because of a low response rate for the Apex handpiece, we are not able to report on usage experiences with that brand.

Respondents were asked to rate the performance of the handpieces for speed during use, ergonomics of the handpiece design and the electronic control interface, weight, balance/grip, size, bur-changing mechanism, noise level, customer/repair service, directions for use/product manual, and infection control.

For all brands, constant power and torque were the two best features. Weight and cost were the two worst qualities associated with these products. We asked a series of questions about electric versus air-rotor handpieces. No single issue emerged specific to any of these brands, but respondents cited several drawbacks to electric handpieces overall: limited access in tight areas, like the posterior area of the mouth; heaviness; costly repairs; long turnaround time for some repairs; and reliability.

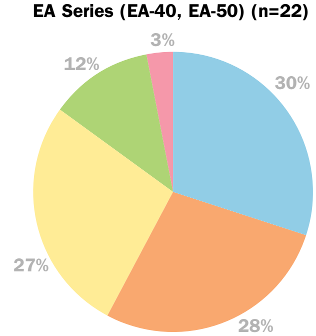
The pie charts give an overall sense of how often the systems rated Excellent, Very Good, Good, Fair, Poor, or Unacceptable for these qualities. For a precise breakdown of how respondents rated each feature, visit "www.ada.org/goto/ppr".

ELECTROtorque plus (n=113)

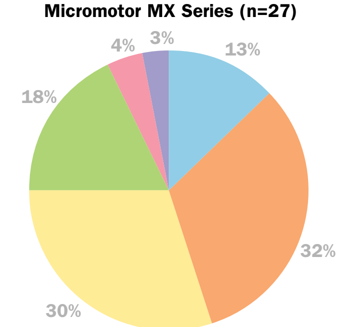


The following ratings are based on the opinions of fewer respondents and may be less reliable than those reported for the ELECTROtorque plus:

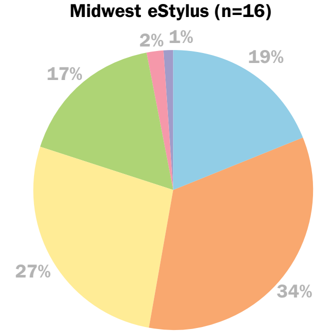
EA Series (EA-40, EA-50) (n=22)



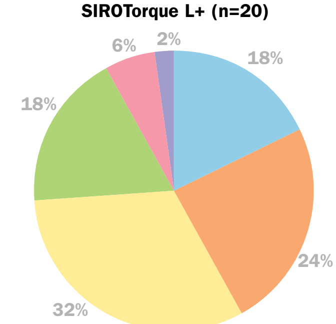
Micromotor MX Series (n=27)



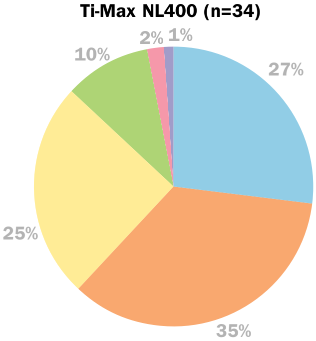
Midwest eStylus (n=16)



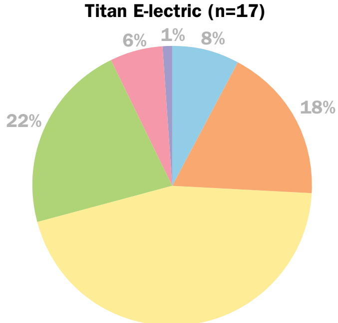
SIROTorque L+ (n=20)



Ti-Max NL400 (n=34)



Titan E-lectric (n=17)



Buyer's Summary for Electric Handpiece Systems.

Product (Manufacturer) No. of Practitioner Input respondents*	Laboratory Performance†		Clinical Impressions*						Cost‡ (Control box, motor)
	Basic Test	Lab Score %	Excellent %	Very Good %	Good %	Fair %	Poor %	Unacceptable %	
Apex (Lares Research) n=4	Pass	60	Not reported due to low response rate						$1,349
EA-40LT (A-dec) n=22	Pass	76	30	28	27	12	3	0	$2,920
ELECTROtorque plus (KaVo) n=113	Pass	77	26	33	26	10	4	1	$2,200
Micromotor MX Series (Bien-Air) n=27	Pass	80	13	32	30	18	4	3	$2,200
Midwest eStylus (DENTSPLY Professional) n=16	Pass	83	19	34	27	17	2	1	$2,507
SIROTorque L+ (Sirona Dental Systems) n=20	Pass	79	18	24	32	18	6	2	$2,499
Ti-Max NL400 (Brasseler USA/NSK) n=34	Pass	95	27	35	25	10	2	1	$1,925
Titan E-lectric (DentalEZ Group/Star) n=17	Pass	81	8	18	45	22	6	1	$1,460

* Via a Web-based survey of dentists who use these products (p 10). Clinical Impressions indicate the percentage of time a rating was selected for a product. Ratings are more reliable when based on a larger number of respondents.
† Run-Out was the Basic Lab Test (p 7). Lab Score is an average calculated for each product based on its weight, visibility angle, light intensity, and ability to achieve the speed set on the control box and maintain that speed as torque increased. For each test, the best performer earned 100 points, and the others earned a percentage based on how their performance compared to the best.
‡ MSRP as of September 2006. Retail prices may vary.

LOCAL ANESTHETIC DELIVERY SYSTEMS

Intraosseous and Intraligamental Local Anesthesia Techniques

Intraosseous (IO) and intraligamental (IL) local anesthesia both work by introducing anesthetic into the cancellous bone, achieving a short-term anesthesia that can be limited to one or two teeth. The IO technique requires that you perforate the cortical plate to allow direct injection of the anesthetic into the bone. The IL approach delivers the anesthetic into the periodontal ligament space; from there, it diffuses into the bone. With either technique, antibiotic prophylaxis is recommended for patients at risk of bacterial endocarditis or those with total joint replacements.[1,2] Tables 1-3 list the advantages, disadvantages and contraindications for both techniques.

Table 1. **IO, IL Anesthesia Delivery: Advantages.**

Characteristic	Intraosseous	Intraligamental
Reliable when used alone or to supplement a standard injection	✓[3-11]	✓[12-14]
Useful for teeth that are difficult to anesthetize (e.g., pulpitis, cracks, etc.)	✓[7,9]	✓[15]
Rapid onset of anesthesia	✓[4,16]	✓[17]
Short duration of anesthesia	✓[4,11,18]	✓[19]
Numbs a limited area without affecting tongue or lips*	✓[5,11,18]	✓[20,21]
Minimum volume of anesthetic needed	--	✓[15,22,23]
Useful for patients with bleeding, clotting disorders	--	✓[23-24]

* Depending on injection site.

Table 2. **IO, IL Anesthesia Delivery: Disadvantages.**

Characteristic	Intraosseous	Intraligamental
Postoperative pain, swelling	✓[11]	✓[25]
Transient increase in heart rate when used with vasoconstrictor-containing solutions	✓[3,6*]	✓[26]
Breakage of perforators	✓[4,10]	--
Risk of localized infection or soft tissue trauma	✓[27]	--
Dense tissue requires slow injection to minimize pressure-related problems (e.g., cartridge breakage, "leak-back" of anesthetic, patient discomfort)	--	✓[28]

* Noticeable increase with IO technique when vasoconstrictors are used (see text).

Table 3. **IO, IL Anesthesia Delivery: Contraindications.**

Characteristic	Intraosseous	Intraligamental
Infection	✓[11,29]	✓[19]
Procedures requiring proper occlusion (e.g., crown placement)	--	✓[19]
Anatomical concerns (e.g., tori, narrow zone of attached gingival, symphyses, insufficient cancellous bone, etc.)	✓[11,29]	--

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