

ADA Professional Product Review®

A Publication of the Council on Scientific Affairs

In This Issue:

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Letter from the Editor - David C. Sarrett, DMD, MS



All good publications do routine evaluations to determine how to best serve their readers, and the ADA Professional Product Review is no exception. Feedback comes to me from many sources—fellow faculty and deans, dental students and others. And, we routinely survey groups of ADA members to get input about topics the newsletter should pursue. Based on that feedback, we are expanding our content to provide a variety of information on dental equipment, materials, occupational safety and health issues and other areas that affect your daily practice.

For this issue, we interviewed Dr. Shannon Mills and Dr. John Tullner for the article, “Surface Disinfectants: What dentists and their staff need to know.” Disinfectant products have been around for decades, but you may be surprised to hear what they have to say about contact time and efficacy. In a new feature, Mailbox, we’ll be answering some of the many questions that ADA members pose to the ADA’s Division of Science, such as “Must I bag all instruments? What if I use them as soon as they have been autoclaved? Can I bag instruments after sterilization? Can I wear a short sleeve lab jacket when it’s hot?”

The ADA Laboratory also did two evaluations for this issue—one on dental unit water treatment systems and one on temperature rise in electric handpieces, which can produce burns. And, if you’re thinking of buying or updating your electronic health records system, you’ll want to read the article by Mike Uretz that looks at things to consider before moving forward.

I’d like to hear from you. What topics would you like to see covered in future issues? Contact me at ppreditor@ada.org.

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Editor

David C. Sarrett, DMD, MS

Chair, ADA Council on Scientific Affairs

Edmond L. Truelove, DDS

Senior VP, Science/ Professional Affairs

Daniel M. Meyer, DDS

Sr. Director, Center for Scientific Strategies & Information

Eugenio Beltrán, DMD, DrPH

Manager, Laboratory Operations

Jamie Spomer, PhD

Program Manager

Nina A. Koziol

Letters to the Editor, Reprints and Permissions

ppreditor@ada.org,
312.440.2840

Internet

ada.org/ppr

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A Laboratory Evaluation of Electric Handpiece Temperature and the Associated Risk of Burns

In December 2007, the U.S. Food and Drug Administration (FDA) issued a Public Health Notification report that warned “healthcare professionals about serious patient injuries, including third degree burns, associated with the use of poorly maintained electric dental handpieces during dental procedures.”¹ The *ADA Professional Product Review* Volume 4, Issue 2 summarized these concerns and presented several FDA-recommended strategies to prevent such injury.² Despite increased awareness of this safety issue, the FDA continues to receive reports regarding injuries and burns associated with electric handpiece use.³

To address concerns about hazardous handpiece temperatures, ADA Laboratory scientists conducted an investigation to determine surface temperatures at various locations on seven electric handpieces. The tests were performed as a preliminary investigation and could be used to establish baseline comparisons of typical surface temperatures on electric handpieces.

Temperature Measurements

ADA investigators measured surface temperatures at various locations on handpieces from seven manufacturers: EA-51LT (A-dec), ELECTROtorque TLC (KaVo), Midwest eStylus (Dentsply Professional), NuTorque (DentalEZ Group/StarDental), Micromotor MX Series (Bien-Air), Ti-Max NL 400 (Brasseler), and SIROTorque L+ (Sirona Dental Systems). Three handpieces were evaluated for each product.

Before testing, the handpieces were subjected to 40 wear-sterilization cycles. One wear-sterilization cycle consisted of having the individual handpiece make four cuts through a 38 mm long ceramic block specimen (Macor, Corning Inc.) using standard 557 burs and a 150 g weight to apply the cutting load. investigators then applied cleaner and/or lubricant according to the manufacturer’s instructions.

Figure A-B. Patient burns caused by electric dental handpieces



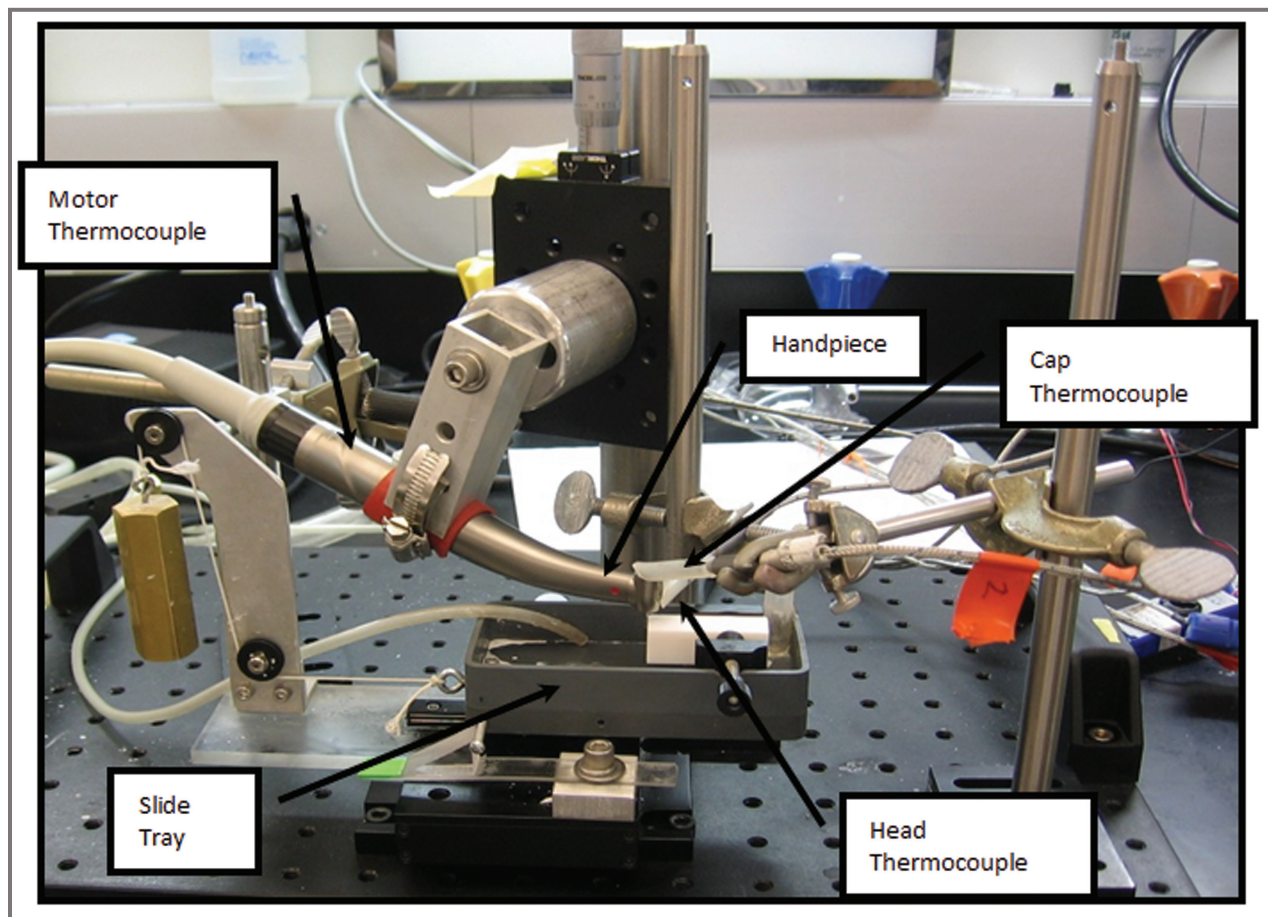


Figure 1. Typical test setup for measuring the surface temperature of electric handpieces under different operating conditions. Thermocouples (T-type) were placed at three locations on each individual handpiece: head, cap, and motor

Table 1. Operating conditions and settings for surface temperature measurements

Step No.	Operating Condition	Drive Air	Chip Air	Chip Water	Duration
1	Handpiece OFF	OFF	OFF	OFF	Start Record
2	Free-run Dry Pre-cut	ON	ON	OFF	~60 sec
3	Free-run Wet Pre-cut	ON	ON	ON	~60 sec
4	Cut 1	ON	ON	ON	*
5	Cut 2	ON	ON	ON	*
6	Cut 3	ON	ON	ON	*
7	Cut 4	ON	ON	ON	*
8	Free-run Wet Post-cut	ON	ON	ON	~30 sec
9	Free-run Dry Post-cut	ON	ON	OFF	~90 sec
10	Handpiece OFF	OFF	OFF	OFF	~120 sec
11	Handpiece OFF	OFF	OFF	OFF	Stop Record

* The cutting time for each cut was the time it took to cut through a 38 mm long Macor ceramic block using a standard 557 bur and a 150 g weight to apply the cutting load

To record the surface temperatures, thermocouples were placed at three different locations on the handpiece: head, cap, and motor (Figure 1). A fourth thermocouple was placed near the handpiece during each test to

measure the ambient air conditions.

Table 1 shows the operating conditions under which the surface temperatures were recorded. At the

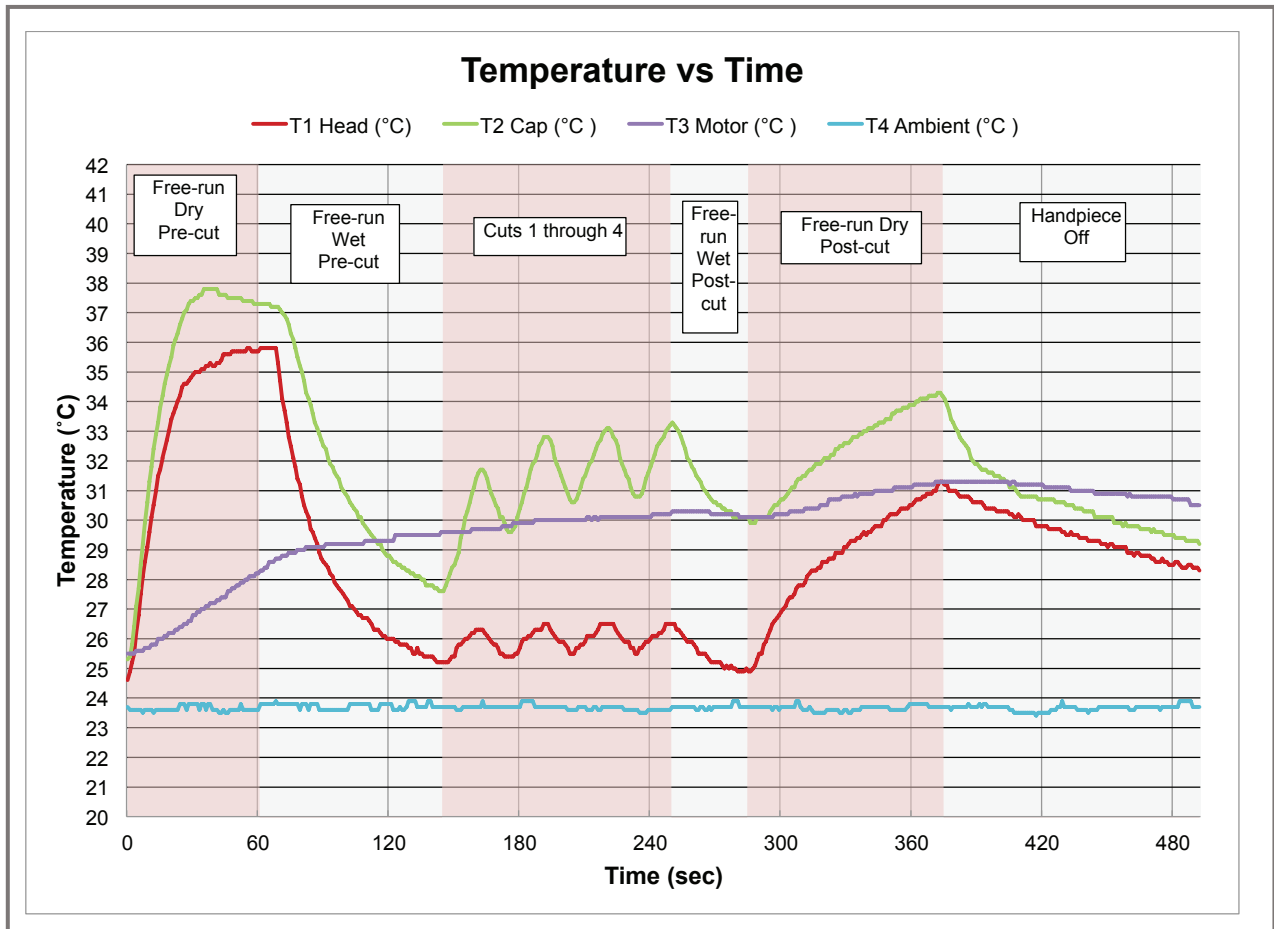


Figure 2. Sample temperature versus time curve for an electric handpiece as tested in this study.

beginning of a test, investigators recorded the temperature with the handpiece control unit set at the maximum operating speed (approx. 200,000 rpm for all handpieces) and with both the drive and chip air on, but the chip water off. After approximately 60 seconds, the chip water was turned on and ran the handpiece for approximately another 60 seconds. We then used 557 burs and a 150 g weight to apply a cutting load and cut through a 38 mm long Macor ceramic block with the handpiece. The procedure was repeated three times, making a total of four parallel cuts in the Macor block. After approximately 60 seconds, the chip water was turned on and the handpiece ran for about another 60 seconds. The handpiece was then run for approximately 30 seconds with the drive air and chip water and air turned on, followed by running the handpiece an additional 90 seconds with the chip water off. Finally, the handpiece was turned off (including all air and water) and the handpiece temperature was recorded for another 120 seconds.

Figure 2 shows a sample temperature versus time

curve for the electric handpieces. (See Appendix A for representative temperature vs. time curves for the individual handpieces.) Each of the tested handpieces followed the general trend of the heads and caps heating up with time when they are run without the chip water. By contrast, after the chip water is turned on, the surface temperature of the handpiece heads and caps decreases. Furthermore, the surface temperatures measured at the motor steadily rise when the chip water is off, and start to level off when the chip water is turned on. These trends demonstrate the importance of having the chip water on whenever the handpiece is running.

Table 2 shows the average maximum surface temperatures for the different handpiece brands. One temperature measurement test was performed on three handpieces for each manufacturer. For each manufacturer, investigators then calculated the average maximum values for each of the thermocouples during the different stages of handpiece operation. During the experiments the ambient room temperature averaged

Table 2. Average maximum surface temperature readings [maximum standard deviation] in degrees Celsius.*†

	EA-51LT (A-dec)			ELECTROtorque TLC (KaVo)			Micromotor MX Series (Bien-Air)			Midwest eStylus (Dentsply Professional)			NuTorque (DentalEZ / Star Dental)			SIROTorque L+ (Sirona Dental Systems)			Ti-Max NL400 (Brasseler)		
	T1 Head	T2 Cap	T3 Motor	T1 Head	T2 Cap	T3 Motor	T1 Head	T2 Cap	T3 Motor	T1 Head	T2 Cap	T3 Motor	T1 Head	T2 Cap	T3 Motor	T1 Head	T2 Cap	T3 Motor	T1 Head	T2 Cap	T3 Motor
Handpiece Off	24.9 [0.8]	25.2 [0.3]	25.3 [0.9]	26.0 [1.2]	26.5 [1.0]	25.3 [0.2]	24.3 [1.1]	24.7 [0.8]	25.3 [0.5]	24.3 [1.2]	24.2 [0.7]	24.8 [2.3]	24.2 [0.9]	24.2 [1.2]	24.8 [1.7]	25.0 [0.5]	24.1 [0.5]	26.4 [0.2]	23.5 [0.5]	24.2 [0.8]	23.7 [0.4]
Free-run Dry Pre-cut	34.2 [1.4]	33.5 [1.5]	27.0 [0.6]	35.0 [2.9]	36.7 [3.5]	27.2 [1.2]	30.7 [2.1]	29.7 [1.1]	27.4 [0.5]	32.3 [1.0]	36.2 [3.2]	27.8 [1.6]	34.4 [3.5]	34.7 [3.1]	27.7 [1.7]	30.1 [0.7]	28.9 [0.7]	26.8 [0.3]	30.6 [2.6]	31.5 [2.4]	25.0 [0.4]
Free-run Wet Pre-cut	33.8 [1.0]	33.4 [1.5]	27.3 [0.7]	36.9 [1.0]	39.0 [1.5]	28.9 [0.8]	30.8 [2.0]	29.8 [1.1]	27.6 [0.5]	33.4 [1.6]	36.8 [3.5]	29.3 [1.2]	34.4 [3.5]	34.9 [3.1]	28.8 [1.5]	30.1 [0.6]	29.0 [0.6]	27.4 [1.5]	31.2 [2.8]	32.0 [2.6]	25.5 [0.2]
Cuts 1 through 4	27.8 [3.1]	30.6 [1.5]	27.5 [0.6]	29.4 [6.9]	35.4 [3.7]	30.0 [0.2]	24.4 [1.2]	25.5 [1.5]	27.5 [0.4]	25.1 [2.6]	30.6 [1.6]	29.6 [0.2]	28.1 [3.0]	29.0 [3.2]	30.0 [1.3]	24.5 [0.4]	27.5 [1.4]	28.1 [2.3]	26.8 [6.2]	29.0 [5.2]	25.5 [0.2]
Free-run Wet Post-cut	25.0 [2.0]	27.2 [2.8]	27.6 [0.6]	24.0 [2.2]	32.7 [0.7]	30.1 [0.2]	23.4 [0.7]	24.2 [1.3]	27.0 [0.7]	26.4 [1.6]	29.7 [2.1]	29.7 [0.8]	27.0 [3.3]	27.9 [4.1]	29.9 [1.3]	23.5 [0.4]	26.6 [1.3]	27.3 [0.8]	23.6 [2.5]	27.6 [2.9]	25.3 [0.1]
Free-run Dry Post-cut	28.2 [3.1]	28.8 [2.3]	28.8 [0.8]	26.3 [4.5]	32.9 [1.2]	30.5 [0.7]	26.0 [2.9]	26.7 [2.3]	27.5 [0.5]	28.5 [3.1]	32.8 [2.2]	30.9 [1.6]	32.0 [3.8]	33.5 [4.3]	30.6 [1.1]	26.0 [1.3]	27.4 [0.7]	27.3 [0.4]	26.4 [2.0]	30.0 [1.9]	26.6 [0.4]
Handpiece Off	28.5 [3.0]	28.8 [2.3]	29.7 [0.5]	27.5 [3.2]	33.0 [0.9]	30.5 [0.7]	26.2 [2.7]	26.7 [2.3]	27.7 [0.5]	28.4 [3.6]	32.7 [1.8]	31.1 [1.1]	31.8 [3.5]	33.4 [4.1]	30.6 [1.1]	26.2 [1.0]	27.4 [0.6]	27.1 [0.2]	26.5 [1.9]	30.0 [2.0]	27.1 [0.2]

* Average maximum values were calculated from one temperature measurement test on each of three handpieces per product. For each manufacturer, the yellow highlighted values are the highest average maximum surface temperature readings for the respective average pre-cutting, cutting, and post-cutting stages.

† Experiments were performed with the ambient room temperature averaging between 23°C to 24°C.

between 23°C and 24°C.

The highest average maximum surface temperatures occurred at the cap or the head of the handpiece during the pre-cutting stage. When comparing the information in Table 2 with that in the Appendix, we see that the high average maximum surface temperatures in the pre-cutting stage occurred when the handpieces were operated with the chip water off. After turning the chip water on, the surface temperatures continued to rise for a short time before sharply decreasing. This further demonstrates the importance of running electric handpieces with the chip water turned on.

The highest recorded average maximum surface temperature during cutting was on the motors of the following handpieces: Micromotor MX Series, NuTorque, and SIROTorque L+. The highest average maximum temperature recorded during cutting was at the caps of the following handpieces: EA-51LT, ELECTROtorque TLC, Midwest eStylus, and Ti-Max NL400. The average maximum surface temperature for three handpieces (ELECTROtorque TLC, Midwest eStylus, and Ti-Max NL400) was consistently highest on the cap under all operating conditions. However, the highest surface temperature recorded for all of the devices was only slightly higher than normal mouth temperature (39.0°C, or 102.2°F), which presents no significant risk for patient burns.

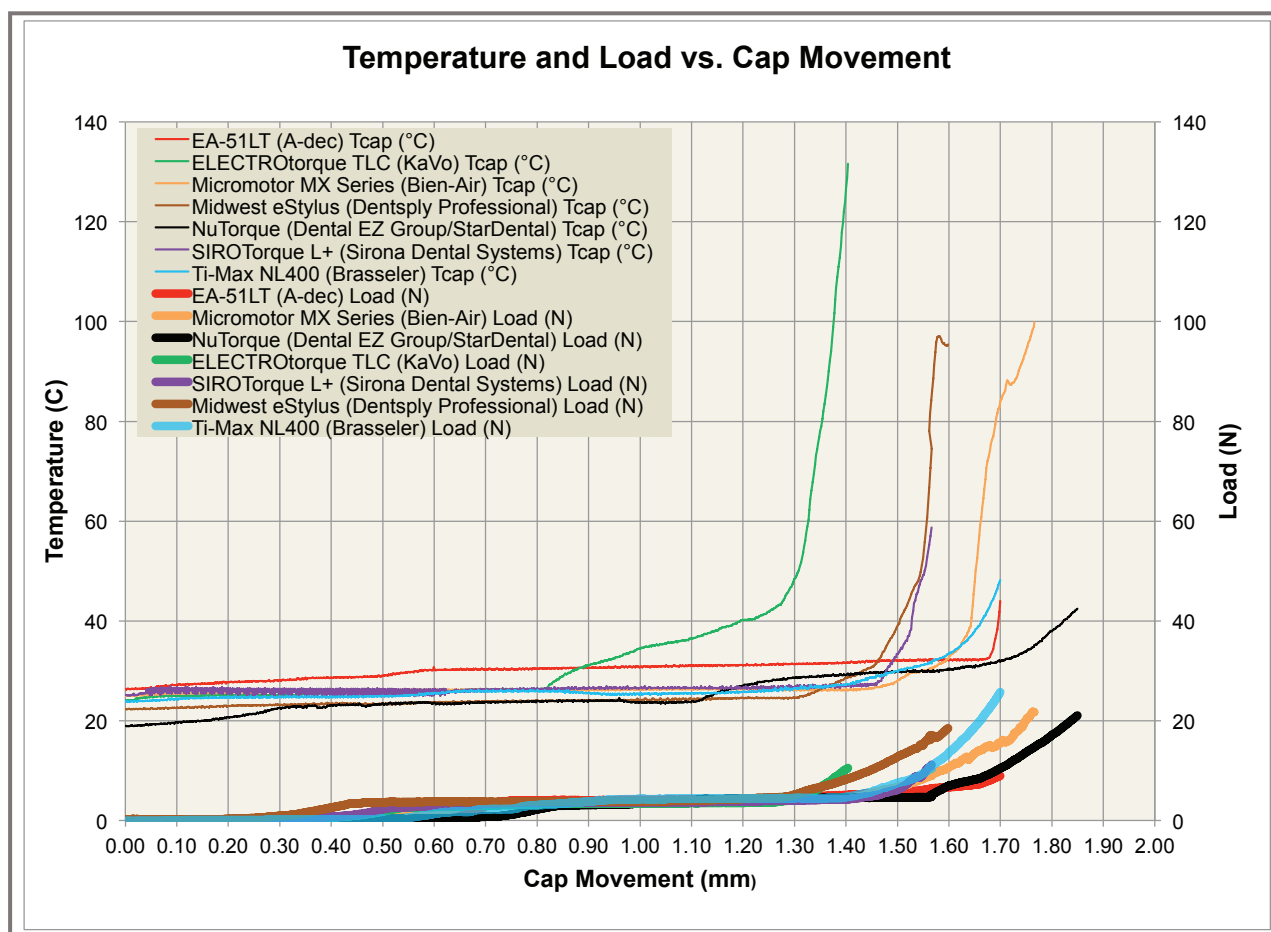


Figure 3. Temperature and Load vs. Cap Movement

Plot of temperature and load versus displacement (cap movement) for each manufacturer.

Temperature measurement with caps pressed during operation

The risk of patient burn is greatly increased when the handpiece cap (button for changing the bur) of any autochuck handpiece is depressed (engaged) while the handpiece is running. This can occur when the button comes in contact with and is depressed by the inside of the patient's cheek. ADA investigators performed additional tests to simulate the clinical situation of the handpiece cap being depressed during operation. Individual handpieces were mounted in a mechanical test machine (Instron, Instron Corp.) and, as the handpiece ran at the maximum operating speed and held a standard 557 bur, the cap was pressed using a rod attached to the Instron. (Pilot tests were conducted to determine the distance each cap moved before expelling the bur.)

The surface temperature of the cap was recorded throughout the test. The force required to depress the cap and the distance the cap moved were also recorded.

We operated one handpiece of each type with drive air, chip air, and chip water on during the test. Figure 3 shows the plot of temperature and load versus displacement for each of the handpieces. Five of the seven handpieces exhibited a similar trend: the Midwest eStylus, EA-51LT, Micromotor MX Series, SIROTorque L+, and Ti-Max NL400 all showed an initial range of cap movement, but no significant change in temperature. However, as the caps were depressed more, a critical region was observed where the cap temperature rose dramatically.

A slightly different trend was observed for the ELECTROtorque TLC (green curves) and the NuTorque (black curves) handpieces. These devices exhibited an increase in cap temperature in a region where cap movement takes place with very little resistance, followed by the previously described region where additional small movements resulted in dangerously high cap temperatures.

Table 3. “Critical” Region values for temperature measurement with caps depressed during operation.

Handpiece	Temp Starts to Increase		Bur Expelled		Max Temp (°C)
	Cap Movement (mm)	Load (N)	Cap Movement (mm)	Load (N)	
EA-51LT	1.67	7.6	1.70	8.9	44
ELECTROtorque TLC	0.81	3.4	1.40	10.6	132
Micromotor MX Series	1.42	4.7	1.77	21.8	100
Midwest eStylus	1.34	6.5	1.60	18.5	97
NuTorque	1.10	4.0	1.85	21.0	42
SIROtorque L+	1.49	5.0	1.60	11.2	59
Ti-Max NL400	1.16	4.4	1.70	25.7	48

Data is for tests performed on one handpiece from each of the seven manufacturers. The “Critical” region is defined from the cap (push button) movement at which the temperature starts to rise up until the point at which the bur is expelled.

Table 3 provides data on the “critical” region for each handpiece, or the region where the cap temperature of the handpiece starts to rise with increasing cap movement. For each individual handpiece tested, the table gives the displacement and load corresponding to a rise in cap temperature. This indicates the beginning of the critical region. The table indicates the maximum distance the cap (push button) was moved (i.e., the point at which the bur is expelled) and the maximum load associated with its resistance to depression. The maximum temperature recorded during the test is also provided.

The data in Table 3 demonstrate that the total cap movement to expel the bur is less than 2 mm for all of the handpieces. Furthermore, the distance the caps could be moved before the temperature of the caps began to rise is in the range of 0.81 mm (ELECTROtorque TLC) to 1.67 mm (EA-51LT). The measured loads at these displacements were 7.6 N and 3.4 N, respectively. However, the load measured to push the cap down to the point of expelling the bur ranged from 8.9 N (about 2 lbs.) for the EA-51LT to 25.7 N (almost 6 lbs.) for the Ti-Max NL400. At the point the bur is expelled, moving parts are touching and the temperature of the handpiece caps rises dramatically, from 42 °C for the NuTorque to 132 °C for the ELECTROtorque TLC. As noted by the American Burn Association, third degree burns can occur in as little as one second when tissue is exposed to temperatures of at least 68 °C; a five minute exposure can cause third degree burns at temperatures of at least 48 °C (Table 4).⁴ Based on this information, the maximum temperature recorded for five of the seven handpieces tested could burn a patient should contact occur for as little as one second or as long as 5 minutes. Furthermore, it should be noted that during testing,

Table 4. Time and temperature relationship to severe burns.*⁴

Time	Temperature	
1 second	68 °C	155 °F
5 seconds	60 °C	140 °F
1 minute	52 °C	127 °F
5 minutes	48 °C	120 °F

*Time required for a third degree burn to occur

the burs were held such that when they were expelled, gravity caused them to drop from the handpieces. However, this may not occur in a clinical situation; it is possible that the handpiece may not be positioned such that the bur drops out, and the temperature could continue to rise.

Bottom Line

The results of the temperature measurement tests performed in this study point to the importance of operating the electric handpieces with the chip water turned on. When we operated the handpieces according to the manufacturer’s instructions, the temperatures of the handpieces did not exceed mouth temperature while cutting through ceramic blocks at room temperature. During cutting, we recorded the highest average maximum handpiece temperatures on either the cap or the motor.

Additional testing showed that pressing down on the handpiece cap (push button) while it is operating can result in dangerously high cap temperatures. A section of the handpiece chucking device, mostly made of metal components, spins at about 200,000 rpm. When the cap is continuously depressed (by touching a patient’s cheek for example), it comes in contact with

the spinning chucking device, which results in friction, causing both components to heat up instantly.

ADA laboratory tests were not designed to predict the longevity of the handpiece; rather investigators wanted to document the effect of use (with and without coolants like water and air) on the temperature of well-maintained, slightly worn handpieces used under normal conditions. As noted by the FDA, “with high and low speed air-driven handpieces, sluggish handpiece performance will alert the dental practitioner to maintenance issues such as a dull bur or worn or

clogged gears or bearings. A poorly maintained electric handpiece does not provide a similar warning that maintenance is needed. Instead, if an electric handpiece is worn, damaged or clogged, the electric motor sends increased power to the handpiece head or attachment in order to maintain handpiece performance. This increased power can rapidly generate heat at the head of the handpiece attachment. Because the heat buildup is so rapid, and is efficiently conducted through the metal handpiece, a burned patient may be the first indication of handpiece problems that the practitioner receives.”¹

ADA Laboratory researchers who participated in this evaluation include Dr. Spiro Megremis and Henry Lukic.

References

1. FDA Public Health Notification: Patient burns from electric dental handpieces. Public Health Notification 1 on Electric Handpieces 12/2007 <http://www.fda.gov/medicaldevices/safety/alertsandnotices/publichealthnotifications/ucm062018.htm> Accessed November 27, 2013.
2. Electric Handpieces: Preventing patient burns. ADA Professional Product Review. Spring 2009;4(2):16. https://www.ada.org/members/sections/scienceAndResearch/0904_ppr.pdf Accessed November 27, 2013.
3. FDA. Letter to electric dental handpiece manufacturers regarding reports of overheating and patient burns: Notice of safety concern for electric dental handpieces and accessories <http://www.fda.gov/MedicalDevices/ResourcesforYou/Industry/ucm226986.htm> Accessed November 2013.
4. American Burn Association. Scald injury prevention educator's guide. <http://www.ameriburn.org/Preven/ScaldInjuryEducator'sGuide.pdf> Accessed November 27, 2013.



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