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Handpieces and Burs: The Cutting Edge

A Peer-Reviewed Publication
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Educational Objectives

The overall goal of this article is to provide the clinician with information on handpiece and bur technologies, as well as the updated guidelines for the sterilization of handpieces and dental burs.

Upon completion of this course, the clinician will be able to do the following:

1. Describe the historical development of handpieces.
2. Describe the types of handpieces currently available and their advantages and disadvantages.
3. Describe the types of burs currently available and their use for specific dental procedures.
4. Describe the appropriate methods for ensuring the sterility of dental handpieces and burs.

Abstract

Dental handpieces and burs are among the most frequently used mechanical devices in dentistry. Handpieces have evolved from primitive cutting tools introduced in the nineteenth century to highly efficient and sophisticated devices. Traditional handpieces are either air-driven or electrically driven. A more recent introduction utilizes technology from both air-driven and electric handpieces, and includes a control mechanism to adapt torque to clinical situations. Burs for dental procedures typically are fabricated from tungsten carbide or diamond particle coatings, with ceramic and zirconia burs also available. Bur designs include many configurations and sizes, with bur selection depending on the type of procedure, the clinician's preference and the bur's overall effectiveness. The selection of an appropriate handpiece and appropriate burs is key for the safe and effective removal of dental hard tissues and caries in an efficient manner that also maximizes ergonomics for the clinician and minimizes patient discomfort. Handpieces and burs become contaminated during dental procedures. To prevent any risk of cross-infection from these devices, all handpieces and burs should be heat sterilized between patients in accordance with the recently published, updated guidelines from the Centers for Disease Control and Prevention.

Introduction

Handpieces and burs are among the most frequently used mechanical devices in dentistry. High-speed handpieces are used for restorative procedures and endodontic access, while low-speed handpieces are used for restorative, oral and periodontal surgery, as well as endodontic, orthodontic, hygiene and laboratory procedures. The first commercial foot-treadle dental engine or drill was manufactured following a patent award in 1871 to James B. Morrison¹; until approximately half a century ago, dentists used belt-driven (belt and pulley) handpieces to cut teeth. Initially only straight handpieces were available. These were slow and laborious to use and uncomfortable for the patient. In the late 1940s, a high-speed air-driven handpiece was introduced following its invention by John Patrick Walsh of New Zealand, and a model known as the Borden handpiece or Airotor, which incorporated a contra-angle design, was subsequently introduced in the United States in the 1950s by Dr. John Borden.

Figure 1. High-speed air-driven handpiece from the 1960s



The other traditional type of handpiece is electrically driven; the first such handpieces were patented in the 1870s.² Early electric handpieces were heavy and cumbersome, resulting in poor ergonomics for the clinician. As both the practice of dentistry and dental technology have progressed, handpieces have evolved. Low-speed handpieces have speeds ranging from less than 100 revolutions per minute (rpm) to typically around 20,000 rpm and up to 40,000 rpm, depending on the type of handpiece. High-speed electric handpieces have a typical speed in the range of 200,000 rpm, while high speed air-driven handpieces operate at up to 400,000 rpm and are usually used within the 180,000 to 330,000 rpm range. Similarly, burs have evolved from crude cutting instruments to highly sophisticated devices in a variety of shapes and materials, used and selected depending on the procedures and the substance to be cut. Modern handpieces and burs have reduced the time required for hard tissue removal and the potential for trauma to the tooth, have diminished patient discomfort, and have improved ergonomics for the patient and clinician alike. In addition to handpieces, over the last two decades first air abrasion and later hard-tissue lasers were introduced as cutting instruments to remove dental hard tissue.

Modern handpieces and burs have reduced the time required for hard tissue removal and the potential for trauma to the tooth

Handpieces and Cutting Instruments

Current high-speed and low-speed handpiece options include traditional air-driven and electric handpieces. Irrespective of the type of handpiece used, the needs of the clinician remain the same – a device that is safe and effective; offers a range of speeds to maximize productivity and minimize trauma to the hard tissues for a given task; enables both gross removal of dental hard tissues and restorative materials as well as preparation refinement; offers sufficient power and torque for procedures; enables easy placement and adequate retention of burs and facilitates their removal following use; minimizes patient discomfort; has a long life; requires minimum, preferably no, routine maintenance; and can be repeatedly sterilized without damaging or reducing the life of the handpiece. From an ergonomics perspective, the handpiece should enable or enhance visualization of the operative field; have a head size and length that maximize access and visibility at the site; have a weight, configuration and grip that is comfortable for the clinician and minimizes operator fatigue and wear; produce minimal noise; and emit no vibration (which also avoids the development over time of hand-arm vibration syndrome in the clinician).³

Table 1. Handpiece requirements

Safe and effective
Wide range of speeds
Maximizes productivity
Minimizes dental trauma
Enables gross hard-tissue removal
Enables preparation refinement
Offers sufficient power and torque
Easy placement and removal of burs
Good bur retention
Minimizes patient discomfort
No maintenance requirements
Longevity
Enables or enhances visualization
Lightweight
Good grip and handle configuration
Ergonomically designed
No noise or vibration
Easy to sterilize

The clinical requirements of handpieces are met by different methods, and to varying degrees, depending on the specific type of handpiece used. While the ideal handpiece does not exist, recently introduced handpieces more closely meet clinical needs than do earlier iterations.

Air-driven handpieces

Air-driven handpieces operate using a compressor to produce compressed air that drives the handpiece. Internally, the handpiece consists of a turbine containing bearings and o-rings, and a chuck mechanism is used to introduce burs, hold the burs while static or rotating during use, and to release them. The chuck utilizes either a friction grip or a push-button mechanism, depending on the model. Friction grip chuck mechanisms are more popular.

Figure 2. Air-driven handpiece turbines



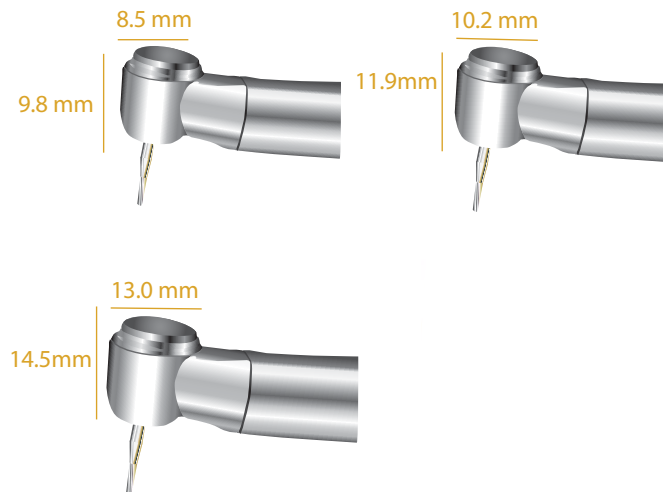
Air-driven handpieces have wider/thinner and longer/shorter handpiece components and varying contra-angle configurations and designs (Stylus, Midwest; Ti-Max NL 9000, NSK; 430 SWL, DentalEZ).

Figure 3. Contemporary high-speed air-driven handpieces



The latest air-driven handpieces are available with full-size, mid-size or miniature heads. Smaller heads and lighter, more ergonomic handles offer greater visibility and reduce the potential for operator fatigue.

Figure 4. Typical high-speed handpiece head sizes



The cutting force used by the clinician during operation of an air-driven handpiece depends on the procedure (cutting of metal versus ceramics for instance) and the torque level of the handpiece. In a study involving 31 dentists preparing Class II preparations, the cutting force used with tungsten carbide burs in traditional air-driven handpieces was found to depend on the handpiece's torque level. Handpieces with a higher torque level were found to result in a mean cutting force of 1.44 Newtons, while lower torque level resulted in a mean cutting force of 1.2 Newtons.⁴

Figure 5. Contemporary low-speed air-driven handpiece attachments



Compared to electric handpieces, air-driven high-speed handpieces offer less power with a lower available torque, and are liable to stall or hesitate during use if increased force is applied or the bur meets a harder material. While it has been suggested that the higher torque of high-speed electric handpieces can result in an increase in tooth cracking or heating, a recent study found no evidence of this.⁵

Smaller heads and lighter, ergonomically-designed handles offer greater visibility and reduce the potential for operator fatigue

Slower speeds are achieved with compressed air by using low-speed handpieces and attachments. These tend to be heavier than high-speed handpieces.

Figure 6. Low-speed air-driven straight handpieces



Maintenance is an important consideration for all types of handpieces to help prevent wear and tear and degradation of internal components. Signs of deterioration in the function of air-driven handpieces include noise or clatter, bearing resistance, increased stalling, and decreased free-running speed. In clinical practice, increased noise often serves as a good proxy for mechanical testing for imminent bearing failure.⁶ At that time, the handpiece must be repaired with new bearings to avoid compromising clinical outcomes as well as overheating of the handpiece as bearing degradation continues. Failure to replace a failing chuck mechanism can result in acentric bur rotation, lowered efficiency and vibration, and in the worst-case scenario can result in injury to the patient caused by a loose or lost bur and includes the potential for swallowing of a bur, or worse yet its inhalation.

In clinical practice, increased noise in air-driven handpieces often signals imminent bearing failure and a requirement to repair the handpiece

In the United States, air-driven handpieces are still the handpiece of choice, although the use of electric handpieces has increased.

Electric handpieces

Electrically driven handpieces operate using a simple electricity supply to power the electric motor through a control unit.

Figure 7. Electric handpiece units



Electric handpieces operate at a minimum speed of 20 rpm and up to 200,000 rpm, depending on the specific handpiece and attachments used. Electric handpieces use a motor, so the attainable rpm is primarily determined by the motor attachment used.

The motor attachments are categorized by their “gear reduction” – whether they increase or decrease the basic speed of the electric motor. Gear reducers range from a high speed of 1:5 to a low speed of 16:1. For preparations, a high-speed attachment is used while a ratio attachment of 1:1 down to 10:1 is used for caries removal, depending on how soft and deep the caries is. A 10:1 ratio and lower is also used for endodontic procedures, composite polishing as well as other procedures.

Figure 8. Electric motor attachments and speed reducers



Recent systems enable smaller variations of the speed at the control unit, as well as allowing the operator to set the desired speed for the procedure and amount of water spray. The control unit may use visual or touch displays, depending on the model.

Given the variation in speeds that can be obtained with motor attachments, a single electric handpiece can be used with differing motor attachments for all high-speed (restorative and endodontic access) and low-speed (restorative, hygiene, endodontic, surgical and laboratory) procedures. Recent trends include the use of fewer micromotor attachments for a greater range of speeds. An air compressor link is still necessary to supply water spray through the handpiece for irrigation and cooling.

Recent trends in electric handpieces include the use of fewer micromotor attachments for a greater range of speeds

Unlike air-driven handpieces, electric handpieces operate at a constant torque, avoiding the potential for reduced speeds and stalling when increased pressure is applied or when old restorations are being removed. It has been suggested that together with the high speed and high torque offered by the electric handpiece, these features result in more precise preparations and better-defined margins; however, one study of Class I preparations (each prepared separately with an electric or air-driven handpiece) carried out by 86 dental students and assessed by a clinical instructor, found that there were no statistical differences in either the specified basic preparation or refinement of the preparation (including well-defined cavosurface margin and flat, smooth walls).⁷ Electric handpieces typically offer quicker preparation and improved cutting efficiency compared to air-driven handpieces.

Electric handpieces operate at a constant torque and typically offer quicker preparation and improved cutting efficiency compared to air-driven handpieces

When using an electric handpiece, attention must be paid to ensure that the head of the handpiece (“back cap area”) does not overheat. Cases have been reported of patient burns – including third-degree burns – associated with overheating of the head of an electric handpiece.⁸ Overheating can occur if an electric handpiece is poorly maintained, because the unit compensates for poor function by automatically increasing power – which in turn rapidly generates more heat. Unlike air-driven handpieces, which perform slowly and haltingly when damaged, malfunctioning is thus less readily apparent until it is advanced. Maintenance of electric handpieces is critical to avoid undetected overheating. In addition, as with air-driven handpieces, failing chuck mechanisms must be replaced.

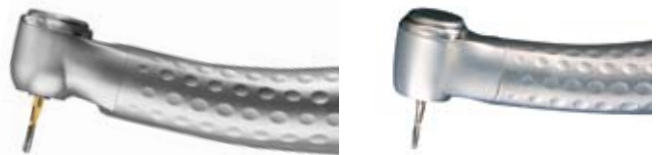
Regular maintenance of electric handpieces is critical to avoid undetected overheating and the potential for patient burns

Electric handpieces are known for their flexible functionality and operation at reduced noise levels. They can be fully integrated into the chairside module with a display box or used as a tabletop model. In addition, unlike early models, current handpieces are lighter, smaller and ergonomically designed to decrease operator fatigue and to maximize visualization of the operative field. Recent electric handpiece models are less cumbersome overall than earlier variants.

Hybrid handpieces – air- and electric-driven features

A hybrid handpiece has recently been introduced that utilizes technology based on both air-driven and electrically driven handpieces. This hybridization has resulted in a handpiece (Stylus ATC) with some of the benefits found in both categories of traditional handpieces.

Figure 9. Stylus ATC handpiece



As with traditional air-driven handpieces, this handpiece operates using a turbine and compressed air. Unlike traditional air-driven handpieces, however, it contains technology that alters the level of torque depending on the task at hand. The adaptive torque control (ATC) is achieved using a torque control unit that monitors the bur speed and adjusts the torque accordingly by automatically increasing the power. In addition, when the bur is not under load, the unit reduces the power and speed to conserve bearings in the turbine.

Figure 10. Torque control unit



The torque control unit can be retrofitted onto an existing chair console by attaching it under the console with the coupling to the handpiece, which sits in the handpiece holders already on the console.

The torque control unit monitors the bur speed and adjusts the torque accordingly by automatically increasing the power

The Stylus ATC handpiece has been designed to offer a clinician-friendly lightweight handle, ergonomic grip and contra-angle design handpiece in mini and medium head sizes to offer the same visualization of the operative field offered by premium traditional air-driven and electric handpieces. It should be noted that an ATC handpiece is compatible only with an ATC unit, and vice versa. The ATC handpiece cannot be used with other systems, and the ATC unit cannot be used with a non-ATC handpiece.

Figure 11. Head sizing

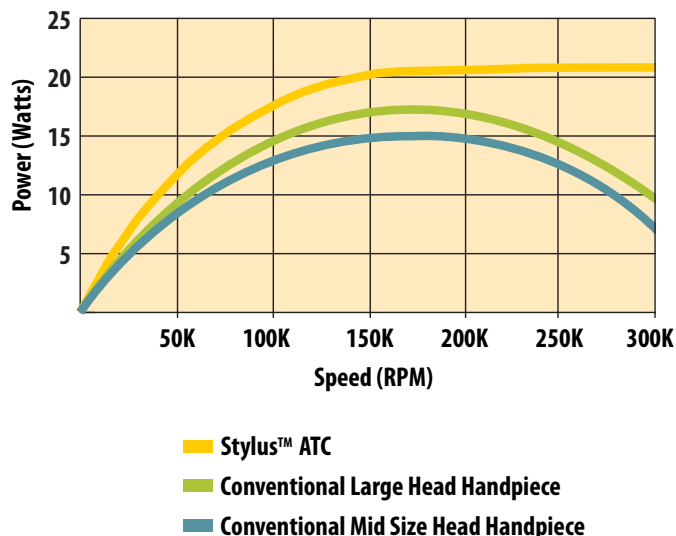


In vitro testing has found differences between this hybrid handpiece and traditional high-speed air-driven handpieces.

Increasing the power to adjust the torque results in a level of efficiency and reduced chairside time for the removal of dental hard tissues and old restorations typically associated with an electric

handpiece. This hybrid handpiece (Stylus™ ATC, Midwest) is lighter than electric handpieces and incorporates a mini or medium-size head, depending on the clinician's preference.

Figure 12. Operating power



As shown in Table 2, electric and air-driven handpieces each have advantages, and ATC handpieces offer hybrid advantages.

Table 2. Air-driven, electric and ATC (hybrid) handpieces

	Air-Driven models	Electric models	ATC models
High torque	No	Yes	Adaptable
Constant bur speed	No	Yes	Yes
Cutting efficiency	+	++	+++
Stalls with increased force	Yes	No	No
High-speed handpieces/attachments	Yes	Yes	Yes
Low-speed handpieces/attachments	Yes	Yes	No
Quiet operation	+	++	++
Integrated fiber-optics	Yes/No	Yes/No	Yes
Push-button chuck	Yes	Yes	Yes
Friction grip chuck	Yes	Yes	Yes
Uses standard/short-shank burs	Yes/No	Yes	Yes
Cross-compatibility of handpieces and units	Some	Some	No
Ergonomics			
Light-weight	Yes	No	Yes
Mini-head	Yes/No	Yes/No	Yes
Swivel feature	Yes/No	Yes/No	Yes
Size	Smaller	Larger	Smaller
Maintenance			
Maintenance requirements	Yes	Yes	Yes
Potential for autoclave degradation	Yes	No	Yes
Risk of head overheating without warning	No	Yes	No

Increasing the power to adjust the torque results in a level of efficiency and reduced chairside time

Air abrasion and hard-tissue lasers

Air abrasion involves the use of a fine silica or aluminum oxide powder sprayed at high speed onto the tooth surface. Precision is required to ensure appropriate tooth preparation and to avoid trauma to soft tissues. When used appropriately by an experienced clinician, air abrasion can offer precise removal of hard tissue; its application is limited, however, because air abrasion cannot be used to remove dental alloys.

Er:YAG (erbium: yttrium-aluminum-garnet) lasers have been introduced that cut dental hard tissues and most recently an Er,Cr3+:YSGG laser that cuts soft and hard tissues (Waterlase MD, Biolase). These have been found to be safe and precise when used appropriately, and to generate the same degree of heat in in vitro studies as a high-speed air turbine.⁹ Er:YAG lasers have been found to produce a microretentive morphological pattern in dental hard tissue.¹⁰ Dental hard tissue lasers have the advantage of not producing any noise or vibration. As with air abrasion devices, hard tissue lasers do not have the ability to remove dental alloys.

Figure 13. Waterlase MD laser



Given these constraints, air abrasion devices and lasers are adjunctive devices in the dental office with high- and low-speed handpieces still required in the same office. In contrast, handpieces can be used for all hard tissue and alloy-cutting procedures.

Air abrasion units and hard-tissue lasers are adjunctive devices

Handpiece Maintenance and Sterilization

With the advent and recognition of HIV infection, and concerns about the transmission of other viruses and micro-organisms, cross-infection of patients resulting from use of dental handpieces is a real concern. Chin et al. conducted an in vitro study followed by an in vivo study of internal contamination in low-speed air-driven handpieces used with prophylaxis angles. In the in vitro study, the investigators assessed contamination inside the nosecone, motor and prophylaxis angles. Using two handpiece types and a sample of 160 tests where the prophylaxis angle end was contaminated in vitro with *Geobacillus stearothermophilus*, it was determined that the motor became contaminated in 20% of cases. When the internal motor was contaminated, on the other hand, the microbes were transmitted to the prophylaxis angle in 47% of 160 other samples.¹¹ In the later in vivo study of 20 subjects, 75% of the 420 samples obtained from slow-speed handpiece/prophylaxis angle systems were found to be contaminated by oral flora.¹² This underscores the importance of thorough cleaning and sterilization of all handpieces between patients to avoid the risk of cross-contamination and cross-infection.

The updated guidelines issued in November 2008 by the Centers for Disease Control and Prevention state that dental offices must heat sterilize handpieces following use in a single patient and recommend that they be steam sterilized (autoclaved).

While autoclaving handpieces is an essential component of current infection control practices, repeated autoclaving over time can result in deterioration and degradation of the turbine; the most recent generation of handpieces, however, is more autoclave-resistant than handpieces available in the early 1990s. A recent study investigated the potential for high-speed air-driven handpiece degradation following repeated sterilization after simulated clinical use. The handpieces were assessed for a number of mechanical parameters – including power, speed, noise, eccentricity and chuck performance – after up to 1,000 simulated uses and sterilizations. The study concluded that increased numbers of cycles resulted in increased eccentricity and that the evaluated handpieces would be effective for at least 500 cycles.¹³ A second study assessing handpiece ball bearings found no degradation after 300 autoclave cycles for any handpieces studied.¹⁴

Updated guidelines issued in November 2008 by the Centers for Disease Control and Prevention recommend that dental offices autoclave handpieces following use in a single patient

To reduce the risk of turbine degradation, the manufacturer's instructions for cleaning, lubricating and sterilizing the handpiece must be followed. A number of techniques are available for cleaning and lubricating prior to autoclaving. Certain cleaning solutions and foam sprays (QUATTROcare Spray, KaVo; STATCARE, STERIS) are available that are introduced into the inner area of the handpiece. Debris must be removed, the inner surfaces cleaned, and the handpiece lubricated. Depending on the spray selected and the manufacturer's instructions, lubrication after autoclaving may or may not be required. In addition to manual cleaning and lubricating, automated machines are available with short cycles of automated

cleaning and lubricating (QUATTROcare, KaVo; H6000, TPC). Another automated system (Assistina, W&H) has a 35-second cycle time and delivers cleaning solution through air/water lines, as well as oiling turbines and chucks prior to sterilization.

Failure to clean handpieces prior to sterilization results in a failure to sterilize the handpiece due to the presence of debris, and also clogs chuck mechanisms and turbines. Failure to lubricate handpieces – with the exception of lube-free handpieces, which do not require lubrication – contributes significantly to early bearing failure.

Handpieces must be sterilized following cleaning and lubrication. If a handpiece cannot be heat sterilized, it should be safely and permanently discarded.¹⁵ Heat sterilization methods include the use of dry heat, chemical vapor or, most commonly, the pressurized steam of an autoclave. The CDC guidelines recommend autoclaving of handpieces (steam sterilization). The instructions from both the handpiece manufacturer and the autoclave manufacturer must be followed to avoid potential damage to the handpiece and to ensure that the sterilization cycle is effective.

Burs

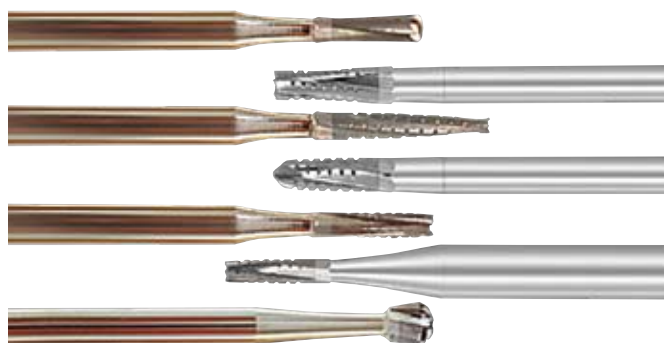
The three basic parts of a bur are the head, the neck and the shank.

Figure 14. Head, neck and shank of a bur



Dental restorative burs are typically made from tungsten carbide or a diamond particle coating of varying degrees of roughness depending on the purpose of the bur, bonded to the underlying metal bur head. Ceramic burs are also available and are used for dental restorative procedures. They can be used for caries removal. Surgical burs are fabricated from tungsten carbide.

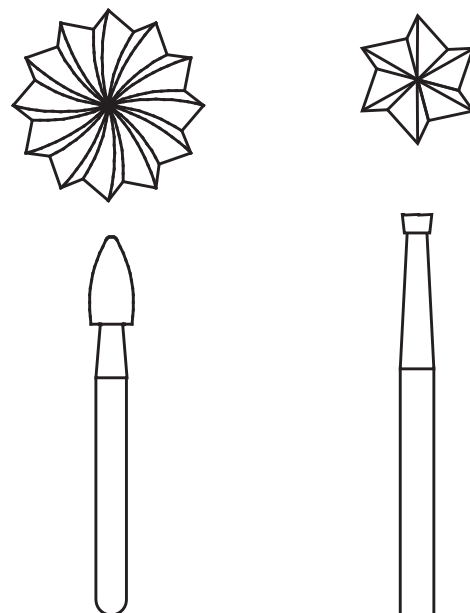
Figure 15. Operative and surgical burs



In the case of tungsten carbide burs, the head contains blades that produce the cutting action. The cutting property of a bur varies with the positioning and the degree of angling of the blades. More obtuse angles will produce a negative rake angle, which increases the strength and longevity of the bur. More acute angles will produce a positive rake angle, which offers a

sharper blade for quicker cutting but which dulls sooner. Additional cuts across the blades, called “crosscuts,” can be added to increase cutting efficiency.

Figure 16. Negative rake angle and positive rake angle



Dental burs are designed with different flute angles and cutting characteristics specific to the task for which they are designed. Operative or cavity preparation burs have flutes (sometimes called “dentates”) that are cut deeper and wider, creating a higher degree of aggressive enamel cutting with increased speed and efficiency. Typically, these operative burs are either straight bladed (plain) or crosscut. Straight-bladed burs cut smoothly but are slower, especially with harder materials; crosscut burs can cut faster due to the lack of debris build-up. In the case of diamond-coated burs, a smooth shape is created and a fine-, medium- or coarse-ground diamond coating is applied over it.

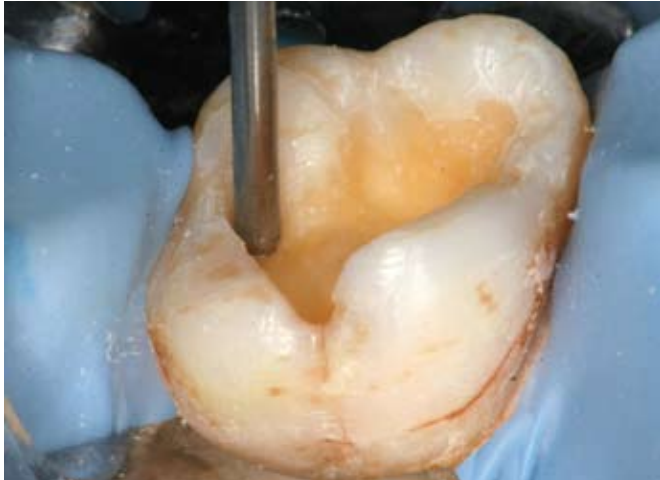
Various bur shapes can be selected, depending on the particular clinical case and the clinician’s preference. Shapes include round, inverted cone, straight fissure, tapered fissure and pear-shaped – each available in a variety of diameters or sizes.

Different shapes of tungsten carbide burs – flat fissure, plain and crosscut – have been found to result in the same cutting force when used in traditional air-driven handpieces with the same levels of torque.¹⁶ As such, shape does not appear to influence cutting force. In addition, specialized restorative burs are available for specific tasks. These include depth-cutting burs – which consist of horizontal ridges across a diamond-fissure bur, providing guidance for the depth to which a fixed restoration preparation should be cut – and end-cutting burs, which are used to trim the floor of mesial and distal preparations in Class II cavities with smooth sides, as they help reduce any possibility of impacting the surface of the adjacent tooth with the cutting surface of a bur. End-cutting burs can also be used to finish the pulpal floor of Class I and Class II cavities, thereby avoiding contact of a cutting surface with the prepared cavity walls.

Figure 17. Depth-cutting and end-cutting burs



Figure 18. End-cutting bur preparing the pulpal floor of a Class I cavity



Tungsten carbide burs recently have been engineered that are more sharply dentated than a crosscut bur and have a unique geometry in the design of their blades (Midwest MultiPrep, Dentsply; Great White, SS White; Razor, AXIS Dental). This creates a bur that cuts faster into tooth structure or dental materials and does not grab or stall during cutting. These innovative burs cut quickly, efficiently and smoothly through metals, composites, enamel and amalgam, saving time and money for clinicians. The beneficial byproducts of this unique design are less chatter and vibration, which reduces hand strain and fatigue. In clinical use, I have found MultiPrep burs consistently outperform operative carbides in the cutting of both tooth and dental restorative materials. These burs are designed to help make restorative dentistry less complicated and more efficient, and ultimately provide a beneficial service to the patient. Other benefits resulting from this design include reduced stress on the tooth and the supporting periodontal structures and less friction. Due to the efficient cutting of this unique bur design, less pressure is required by the dentist to initiate and complete a cut; cutting is smoother and more accurate; and there is less heat generation. Fine crosscut burs are optimal for all phases of restorative dentistry. Due to the bur's design, it is an effective and efficient bur for the removal of amalgam, composite resin, cast-gold and direct-gold restorations that are being replaced. Fine crosscut burs can accomplish multiple steps, which reduces the number of times the clinician must stop during a procedure to swap out burs – improving efficiency as well as reducing wear on chucks and reducing the number of burs that must be sterilized per procedure.

Figure 19. MultiPrep burs



The clinical cases below demonstrate the use of multiple-shape burs and MultiPrep burs for restorative procedures ranging from gross removal of tooth structure to removal of dental materials resistant to cutting.

Case 1. Removal of a fixed restoration

Cutting through porcelain is best accomplished using a diamond bur. A diamond-fissure bur maximizes the length of area removed at one time. Following this, metal is best removed using a tungsten carbide bur. Finally, the underlying preparation is refined using a tapered-fissure bur. A Stylus ATC handpiece was used for all steps.

Figure 20. Removal of porcelain using a diamond fissure bur



Figure 21. Removal of alloy using a MultiPrep bur



Figure 22. Alloy sectioned using MultiPrep bur



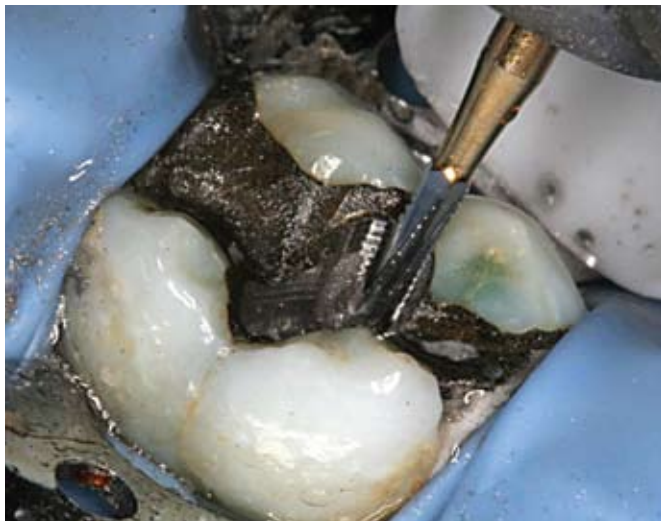
Case 2. Removal of an existing amalgam

Fast, efficient removal of amalgam is best accomplished with a tungsten carbide bur. Fast efficient removal of amalgam can be obtained using straight-fissure bur, as well as MultiPrep pear shaped burs (332) and fine crosscut burs (557).

Figure 23. Use of #332 pear-shaped bur



Figure 24. Use of #557 fine cross-cut bur



Case 3. Removal of caries

Caries present can be safely removed using a round tungsten carbide (size 2, 4, 6 or 8) at slow speed. Using a round tungsten carbide at slow speed helps to remove the minimal amount of dental hard tissue while also removing the softer carious areas and, in the case of deeper cavities, reducing the risk of iatrogenic pulpal exposure. Alternatively, a ceramic round bur can be used (CeraBur K1SM, Komet). If desired, a caries detection solution can be used to ensure that the caries is thoroughly removed (Exposé, Centrix). Following caries removal, a finer smoother carbide or diamond can be used to complete the preparation, prior to restoring the tooth. The cases below demonstrate the use of this two-stage approach using fissure burs followed by large round burs.

Using a round tungsten carbide (size 2, 4, 6 or 8) or round ceramic bur at slow speed helps to remove the minimal amount of dental hard tissue while removing the softer caries

Figure 25. #330 carbide bur used to prepare occlusal tooth #31



Figure 26. #4 round carbide bur removing decay at slow speed



Figure 27. #557 carbide bur preparing occlusal-lingual outline form tooth #3

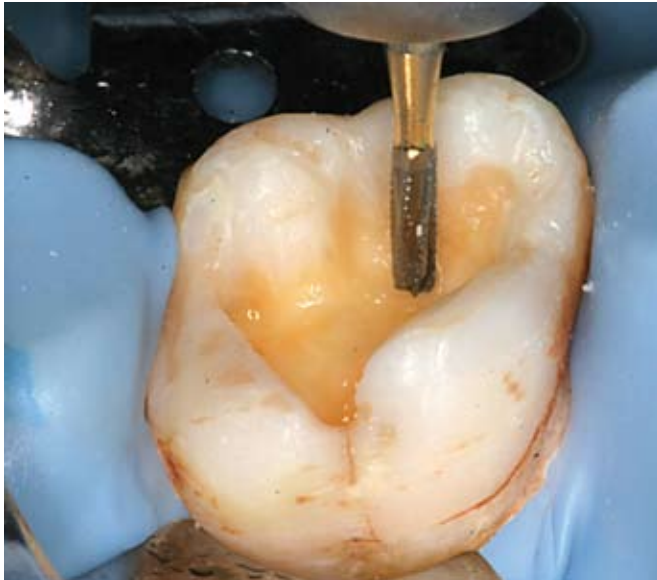


Figure 28. Round ceramic bur removing decay at slow speed



Finishing burs

Finishing burs fabricated from tungsten carbide have more flutes closer together and shallower than do operative burs, for the fine finishing and polishing of dental materials (Esthetic Finishing, Midwest). Either diamond or tungsten carbide finishing burs can be used to remove composite and to improve the smoothness of the restoration prior to polishing with cups/discs/liquid polish, which optimizes smoothness and thus reduces the potential for biofilm development on the composite's surface.¹⁷

Cleaning and sterilizing burs

Following completion of a patient's procedure, the burs must be examined. Worn or damaged burs and any single-use, disposable burs (Talon, Tri Hawk) must be discarded and safely disposed of. Using a worn or damaged bur results in poorly

executed and inaccurate preparations, trauma to dental hard tissue, and reduced efficiency. In addition, in the case of electric handpieces, worn or damaged burs reduce cutting efficiency and cause the unit to compensate for this by increasing power, which can result in overheating of the handpiece head and burning of a patient's oral mucosa.¹⁸

Once it has been determined that burs can be reused, they must be cleaned and then sterilized. Before proceeding, the staff member responsible for this must don utility gloves. Prior to cleaning, burs should be presoaked in a container of soapy water to loosen debris. In the case of diamond burs, an enzymatic cleaning solution (Diamond-Zyme, AXIS Dental) can be used that retards dulling of the diamond coating during sterilization procedures. Ultrasonic systems also may be used to loosen debris, provided that the burs are separated from each other in a bur block during immersion to prevent damage. Following soaking and/or ultrasonic cleaning, any remaining debris must be brushed away from the bur using a stainless steel wire brush, and the burs then must be rinsed under running water. Manual scrubbing to remove debris from burs has been found to be more effective when carried out under running water than in air.¹⁹ After rinsing, the burs must be thoroughly dried by placing them on absorbent towels and patting all bur surfaces. Presterilization cleaning of burs can also be performed using a washer-disinfector, which has been found to be more effective than manual cleaning of contaminated dental burs,²⁰ and which reduces exposure of dental personnel to contaminated devices.

Bur sterilization is achieved using heat. Surgical burs are classified as critical instruments and must be heat sterilized. Nonsurgical dental burs that may contact oral tissues (therefore, all dental burs except laboratory burs) are classified as semicritical; since these are heat resistant, they should be heat sterilized in accordance with the CDC guidelines.²¹ Cold sterilizing solutions are not recommended for heat-resistant semicritical instruments; in addition, they contain oxidizing agents that may weaken carbide burs.

Heat sterilization of burs can be achieved using a dry heat sterilizer or an autoclave. For dry heat sterilization, the burs should be sterilized at 170°C (340°F) for one hour. This method, when used according to the manufacturer's instructions, will not corrode or dull carbide burs. If using an autoclave, the burs should be sterilized at 121°C (250°F) for a 20-minute cycle at 15 p.s.i. Steam autoclaves will effectively sterilize burs; however, potential for corrosion is present.

Summary

Dental handpieces and burs have become more efficient, ergonomic, and user- and patient-friendly in recent years with the introduction of faster, more effective burs and new handpieces. Considering the technological advances found in the latest generation of burs and handpieces, a clinician can select a handpiece and burs that more closely meet the demands of daily clinical practice, increasing efficiency and producing ergonomic benefits. The recent update on infection control guidelines from the Cen-

ters for Disease Control and Prevention underscores the requirement for heat sterilization of all dental handpieces and suitable sterilization methods for both handpieces and dental burs.

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Author Profile



Dr. David Little is a national and international speaker, professor, author and researcher. A graduate of The University of Texas Health Science Center at San Antonio, he approached dentistry with a vision for merging conservatism and progressiveness in a practice that focused on total patient care through a team concept. Dr. Little's private practice in San Antonio includes a multidiscipline state-of-the-art facility. In addition, Dr. Little serves as an adjunct clinical professor at the UTHSCSA dental school, serve on the editorial board of *Contemporary Esthetics*, and is a partner with Pinnacle Practices, Inc. He is a fellow in the International and American Colleges of Dentistry, a member of the ADA, AGD, AACD, and the ALD. All of his programs unite clinical advancements and technology, including practice management for simple implementation into private practice. His passion for dentistry and his enthusiasm for the team concept specifically enliven and motivate all who hear him.

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Questions

- The first high-speed air-driven handpiece in the United States was introduced in the _____.
 - 1930s
 - 1940s
 - 1950s
 - 1960s
- The first electric handpiece was patented in the 1890s.
 - True
 - False
- Low-speed handpieces have speeds ranging from less than _____ revolutions per minute (rpm) to up to _____ rpm.
 - 50; 20,000
 - 100; 30,000
 - 100; 40,000
 - 100; 50,000
- Clinician needs for a handpiece include a device that _____.
 - is safe and effective
 - offers sufficient power and torque for procedures
 - maximizes productivity
 - all of the above
- An ergonomically designed handpiece must _____.
 - have a large head size and be straight-handled
 - have a small head size and be straight-handled
 - have a weight, configuration and grip that is comfortable for the clinician
 - have a small head size and be contra-angled
- The cutting force used by the clinician during operation of an air-driven handpiece depends on the procedure (cutting of metal versus ceramics for instance) and the torque level of the handpiece.
 - True
 - False
- Compared to electric handpieces, air-driven high-speed handpieces offer _____.
 - more power with greater available torque
 - less power with lower available torque
 - more power with lower available torque
 - none of the above
- Signs of deterioration in the function of air-driven handpieces include _____.
 - noise
 - decreased free-running speed
 - increased stalling
 - all of the above
- In the United States, air-driven handpieces are still the handpiece of choice, although the use of electric handpieces has increased.
 - True
 - False
- Electric handpieces operate at a constant torque.
 - True
 - False
- Electric handpieces use a motor with the attainable rpm primarily determined by the _____ used.
 - gear multiplication of the motor attachment
 - gear reduction of the motor attachment
 - gear enhancement of the turbine
 - all of the above
- Recent electric handpiece systems enable smaller variations of the speed at the control unit.
 - True
 - False
- Electric handpieces typically offer _____ and _____ compared with air-driven handpieces.
 - quicker preparation; improved cutting efficiency
 - lower visualization; quicker preparation
 - slower preparation; lower cutting efficiency
 - none of the above
- Maintenance of electric handpieces is critical to avoid undetected overheating.
 - True
 - False
- A handpiece with adaptive torque control has a unit that _____ and _____ by automatically increasing the power.
 - monitors the temperature of the bur; adjusts the torque accordingly
 - monitors the temperature of the handpiece; adjusts the torque accordingly
 - monitors the bur speed; adjusts the torque accordingly
 - all of the above
- A torque control unit can be retrofitted onto an existing chair console.
 - True
 - False
- In a handpiece with adaptive torque control, increasing the power to adjust the torque results in _____ and _____ for the removal of dental hard tissues.
 - an increased level of efficiency; increased chair-side time
 - more oscillating current; an increased level of efficiency
 - an increased level of efficiency; reduced chair-side time
 - none of the above
- Air-driven, electric and adaptive torque control handpieces all offer cross-compatibility of handpieces and units.
 - True
 - False
- Air abrasion units and hard-tissue lasers are stand-alone devices for all restorative procedures.
 - True
 - False
- Updated guidelines issued by the Centers for Disease Control and Prevention recommend that dental offices autoclave handpieces following use in a single patient.
 - True
 - False
- Failure to clean handpieces prior to sterilization results in _____.
 - the autoclave working harder to perform sterilization and discoloration of the autoclave walls
 - failure to sterilize the handpiece due to the presence of debris
 - clogged chuck mechanisms and turbines
 - b and c
- Dental burs can be made from _____.
 - tungsten carbide
 - a diamond particle coating
 - ceramics or zirconia
 - all of the above
- The cutting property of a bur varies with the _____ and the _____.
 - positioning; degree of angling of the blades
 - positioning; degree of bevel of the head
 - reduction angle; degree of angling of the blades
 - none of the above
- Additional cuts across the blades of burs, called "crosscuts," increase cutting efficiency.
 - True
 - False
- Different shapes of tungsten carbide burs – flat fissure, plain and crosscut – have been found to result in the same cutting force when used in traditional air-driven handpieces with the same levels of torque.
 - True
 - False
- Depth-cutting burs, which consist of horizontal ridges across a diamond-fissure bur, _____.
 - provide guidance for the depth to which surgical relief areas should be cut
 - provide guidance for the depth to which a fixed restoration preparation should be cut
 - provide guidance for the depth to which endodontic access cavities should be cut
 - all of the above
- Tungsten carbide burs that are more sharply dentated than crosscut burs and have a different blade geometry _____ and _____.
 - cut more carefully; need more power
 - cut faster; do not stall during cutting
 - cut faster; never corrode
 - none of the above
- Fine crosscut burs can accomplish multiple steps, reducing the number of times the clinician must stop during a procedure to swap out burs.
 - True
 - False
- Finishing burs fabricated from tungsten carbide have _____ than do operative burs.
 - more flutes closer together
 - fewer flutes farther apart
 - fewer flutes closer together
 - any of the above
- Heat sterilization of burs can be achieved by using a dry heat sterilizer or an autoclave.
 - True
 - False

Handpieces and Burs: The Cutting Edge

Name: _____ Title: _____ Specialty: _____

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Requirements for successful completion of the course and to obtain dental continuing education credits: 1) Read the entire course. 2) Complete all information above. 3) Complete answer sheets in either pen or pencil. 4) Mark only one answer for each question. 5) A score of 70% on this test will earn you 4 CE credits. 6) Complete the Course Evaluation below. 7) Make check payable to PennWell Corp.

Educational Objectives

- Describe the historical development of handpieces.
- Describe the types of handpieces currently available and their advantages and disadvantages.
- Describe the types of burs currently available and their use for specific dental procedures.
- Describe the appropriate methods for ensuring the sterility of dental handpieces and burs.

Course Evaluation

Please evaluate this course by responding to the following statements, using a scale of Excellent = 5 to Poor = 0.

1. Were the individual course objectives met?	Objective #1: Yes No	Objective #3: Yes No
	Objective #2: Yes No	Objective #4: Yes No
2. To what extent were the course objectives accomplished overall?	5 4 3 2 1 0	
3. Please rate your personal mastery of the course objectives.	5 4 3 2 1 0	
4. How would you rate the objectives and educational methods?	5 4 3 2 1 0	
5. How do you rate the author's grasp of the topic?	5 4 3 2 1 0	
6. Please rate the instructor's effectiveness.	5 4 3 2 1 0	
7. Was the overall administration of the course effective?	5 4 3 2 1 0	
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