

# Additional Information on Instruments and Equipment for Tooth Preparation

Terrence E. Donovan, R. Scott Eidson

## Sharpening Hand Instruments

Selecting the proper hand cutting instrument and using the proper instrument grasp mean little if the instruments are not sharp. Instruments with dull cutting edges cause more pain to the patient, prolong operating time, are more difficult to control, and reduce quality and precision in tooth preparation. It is essential that all cutting instruments be sharp. Re-sharpening requires little time and is rewarding. The dentist or the assistant should regularly test the instruments for sharpness, and when indicated, the hand instruments should be sharpened before they are placed in the tray setup, thus preventing delays in starting or completing an operation (see the section on sharpness test below).

Many types of sharpening equipment exist, including stationary sharpening stones, mechanical sharpeners, and stones that are used in the handpiece. One type or design usually does not accommodate the full variety of dental instruments with their various shapes of cutting edges. For efficient and effective sharpening, the dentist must seek out the most suitable equipment.

## Stationary Sharpening Stones

The most frequently used sharpening equipment consists of a block or stick of abrasive material called *stone*. The stone is supported on a firm surface, and the instrument is oriented and held by hand while being stroked against the stone surface. Stationary stones are often called *oilstones* because of the common practice of applying a coating of oil on them as an aid to the sharpening process. Sharpening stones are available in a variety of grits, shapes, and materials.

Stationary oilstones are available in coarse, medium, and fine grits. Only a fine-grit stone is suitable for the final sharpening of dental instruments to be used for tooth preparation. Coarse and medium grits may be used for initial reshaping of a badly damaged instrument or for sharpening other dental equipment

such as bench knives. Coarser stones cut more rapidly but produce a rougher surface. If the use of two or more grits is required, the coarser one is used as little as needed for reshaping, and then the final sharpening is done with a fine stone.

Stationary stones can be obtained in various shapes, including flat, grooved, cylindrical, and tapered. Flat stones are preferred for sharpening all instruments with straight cutting edges; other shapes are most useful for sharpening instruments with curved cutting edges. Cylindrical stones are used for sharpening instruments with concave edges, and tapered stones permit the use of a portion of the stone with a curvature matching that of the instrument.

Sharpening stones are made from any of several natural or synthetic materials. The normal manufacturing process for the synthetic materials involves pressing carefully sized particles of an abrasive into the desired shape and heating to form a solid. To maintain sharp edges on the particles, the process must result in a porous material. The properties of the stone depend on the volume and size of the pores and on the composition and size of the abrasive. Four types of materials are in common use for sharpening stones: Arkansas stone, silicon carbide (SiC), aluminum oxide, and diamond.

Arkansas stone is a naturally occurring mineral containing microcrystalline quartz and traditionally has been the preferred material for fine sharpening stones. It is semi-translucent, white or gray in color, and hard enough to sharpen steel, but not carbide instruments. Arkansas stones are available in hard and soft varieties. The hard stone, although it may cut more slowly, is preferable because the soft stone scratches and grooves easily, rendering it useless. These stones should be lubricated with light machine oil before being used. This assists in the fineness of sharpening, prevents clogging of the stone pores, and avoids the creation of heat, which alters the temper of the steel blade. An Arkansas stone should be covered with a thin film of oil when stored. During the sharpening of an instrument, the fine steel cuttings remain on the stone and tend to fill up the pores of the stone; when the stone appears

dirty, it should be wiped with a clean woolen cloth soaked in oil. If the stone is extremely dirty or difficult to clean, it may be wiped with a cloth soaked in alcohol.

SiC is widely used as an industrial abrasive. It is the most commonly used material for grinding wheels and “sandpapers” and for sharpening stones. It is hard enough to cut steel effectively, but not hard enough to sharpen carbide instruments. SiC stones are available in many shapes in coarse and medium grits, but not in fine grits. As a result, they are not as suitable as other materials for the final sharpening of dental instruments. SiC stones are normally of a dark color, often black or greenish black. These stones are moderately porous and require lubrication with a light oil to prevent clogging.

Aluminum oxide is increasingly used to manufacture sharpening stones. Aluminum oxide stones commonly are produced in various textures from different particle sizes of abrasive. Coarse and medium grit stones generally appear as speckled tan or brownish in color. Fine-grit stones are usually white, have superior properties, and are less porous so that they require less lubrication during use. Either water or light oil is adequate as a lubricant.

Diamond is the hardest available abrasive and is most effective for cutting and shaping hard materials. It is the only material routinely capable of sharpening carbide and steel instruments. Diamond hones are small blocks of metal with fine diamond particles impregnated in the surface. The diamonds are held in place by an electroplated layer of corrosion-resistant metal. Most hones include grooved and rounded surfaces and a straight surface and are adaptable for sharpening instruments with curved blades. These hones are nonporous, but the use of a lubricant extends the life of the hones. They may be cleaned with a mild detergent and a medium-bristle brush.

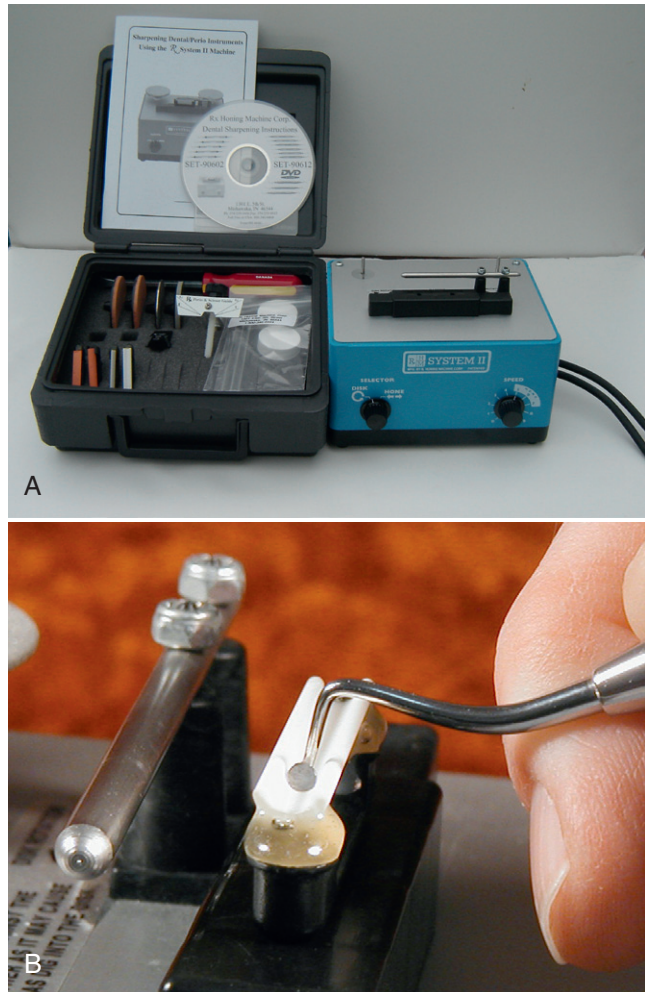
## Mechanical Sharpeners

As high-speed rotary cutting instruments have been improved and their use has increased, the use of hand cutting instruments and the need for re-sharpening has decreased. As a result, some dental office personnel do not do enough hand sharpening to remain confident of their proficiency. Under such circumstances, the use of a powered mechanical sharpener is beneficial.

The Rx Honing Machine (Rx Honing Machine Corp, Mishawaka, IN) is an example of a mechanical sharpener (Online Fig. 23-1). This instrument moves a hone in a reciprocating motion at a slow speed, while the instrument is held at the appropriate angulation and supported by a rest. This is much easier than holding the instrument at the proper angulation while moving it relative to the hone. Interchangeable aluminum oxide hones of different shapes and coarseness are available to accommodate the various instrument sizes, shapes, and degrees of dullness. Restoration of the cutting edge is accomplished more easily and in less time than by other sharpening methods. This type of sharpener is also very versatile and, with available accessories, can fill almost all instrument sharpening needs.

## Handpiece Sharpening Stones

Mounted SiC and aluminum oxide stones for use with straight and angle handpieces are available in various sizes and shapes



**Online Fig. 23-1 A,** The Rx Honing Machine shown is used as mechanical sharpener for many different types of dental instruments. It has two spindle drives, one clockwise and the other counterclockwise, to which can be mounted different types of disks and hones to polish and sharpen various types of dental instruments. **B,** The RX Honing Machine shown using a ceramic hone to sharpen a Black spoon dental instrument to extend the life of the instrument.

(see the section on other abrasive instruments). Those intended for use in straight handpieces, particularly the cylindrical instruments with straight-sided silhouettes, are more useful for sharpening hand instruments than are the smaller points intended for intraoral use in the angle handpieces. Because of their curved periphery, it is difficult to produce a flat surface using any of these instruments. These stones also may produce inconsistent results because of the speed variables and the usual lack of a rest or guide for the instrument. Satisfactory results can be obtained, however, with minimal practice, especially on instruments with curved blades.

## Principles of Sharpening

Most operative hand cutting instruments can be sharpened successfully on either a stationary stone or the mechanical sharpener. The secret to easy and successful sharpening is to sharpen the instrument at the first sign of dullness and not wait until the edge is completely lost. If this procedure is

followed, a fine cutting edge is restored with a few strokes on a stationary stone or a light touch to the mechanical sharpener. At the same time, operating efficiency is not reduced by attempting to use an instrument that is getting progressively duller.

The choice of equipment used for sharpening is up to the dentist. In the use of any equipment, several basic principles of sharpening should be followed:

1. Sharpen instruments only after they have been cleaned and sterilized.
2. Establish the proper bevel angle (usually 45 degrees) and the desired angle of the cutting edge to the blade before placing the instrument against the stone, and maintain these angles while sharpening.
3. Use a light stroke or pressure against the stone to minimize frictional heat.
4. Use a rest or guide, whenever possible.
5. Remove as little metal from the blade as possible.
6. Lightly hone the unbeveled side of the blade after sharpening, to remove the fine bur that may have been created.
7. After sharpening, resterilize the instrument along with other items on the instrument tray setup.
8. Keep the sharpening stones clean and free of metal cuttings.

### **Mechanical Sharpening Techniques**

When chisels, hatchets, hoes, angle formers, or gingival margin trimmers are sharpened on a reciprocating honing machine (i.e., sharpener), the blade is placed against the steady rest, and the proper angle of the cutting edge of the blade is established before starting the motor. Light pressure of the instrument against the reciprocating hone is maintained with a firm grasp on the instrument. A trace of metal debris on the face of a flat hone along the length of the cutting edge is an indication that the entire cutting edge is contacting the hone (see Fig. 23-1, B).

The mechanical sharpener is easily mastered with a little practice and is a quick method of sharpening hand instruments. Regardless of the type of mechanical sharpener used, the associated instructions for use should be thoroughly understood before attempting to sharpen any type of instrument.

Handpiece stones are used chiefly for instruments with curved blades, especially for the inside curve of such blades. The handpiece should be run at a low speed. The instrument is held lightly against the stone with a modified pen grasp, and whenever possible, the ring and little fingers of each hand should be touching each other to act as a rest or steadying force. When this method of sharpening is used, care must be exercised not to overheat the instrument being sharpened. The use of some form of lubricant or coolant is advisable. If oil is used, care should be exercised to ensure that oil is not thrown from the stone during sharpening, and the stone should be reserved for future sharpening only.

An instrument such as an amalgam knife or a gold knife has a wide blade with a narrow edge bevel, in contrast to the wide bevel of a chisel or hatchet. It is difficult to maintain the narrow edge bevel by using a mechanical sharpener or a handpiece stone. This type of instrument should be sharpened on a stationary stone.



**Online Fig. 23-2** Sharpening an instrument. Maintaining the proper angle of bevel and angle of the cutting edge to the stone is aided by resting the fingertips on the stone.

### **Stationary Stone Sharpening Techniques**

The stationary sharpening stone should be at least 2 inches wide and 5 inches long because a smaller stone is impractical. It also should be of medium grit for hand cutting instruments. Before the stone is used, a thin film of light oil should be placed on the working surface. In addition to establishing the proper 45-degree angle of the bevel and the cutting edge to the stone, several fundamental rules apply to using the stationary stone:

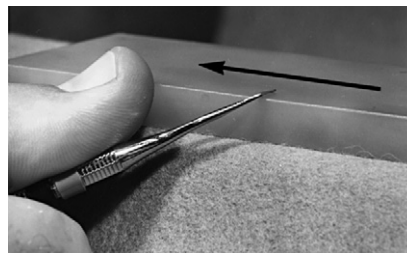
1. Lay the stone on a flat surface, and do not tilt the stone while sharpening.
2. Grasp the instrument firmly, usually with a modified pen grasp, so that it does not rotate or change angles while being sharpened.
3. To ensure stability during the sharpening strokes, use the ring and little finger as a rest, and guide along a flat surface or along the stone. This prevents rolling or dipping of the instrument, which results in a distorted and uneven bevel.
4. Use a light stroke to prevent the creation of heat and the scratching of the stone.
5. Use different areas of the stone's surface while sharpening because this helps prevent the formation of grooves on the stone that impair efficiency and accuracy of the sharpening procedure.

When sharpening chisels, hatchets, or hoes on the stationary stone, grasp the instrument with a modified pen grasp, place the blade perpendicular to the stone, and tilt the instrument to establish the correct bevel (Online Fig. 23-2). Establishing and maintaining this correct bevel is the most difficult part of sharpening on a stationary stone. One method that assists in establishing the proper bevel angle is to observe the oil on the stone while the instrument is tilted, in an effort to establish contact between the entire bevel and the stone. When oil is expressed evenly on all sides, the entire bevel is touching the stone, and the proper angle has been established to proceed with the sharpening strokes. If this alignment is altered during sharpening, discrepancies of the cutting edge and bevel result. Using the finger rests and guides as illustrated in Online Figure 23-2, the operator can slide the instrument back and forth along the stone. The motivating force should be from the shoulder so that the relationship of the hand to the plane of





**Online Fig. 23-3** Sharpening the gingival margin trimmer. The palm-and-thumb grasp may be used while holding the stone in the opposite hand to establish a proper cutting edge angle.



**Online Fig. 23-4** Sharpening an amalgam knife or a gold knife. The stone is placed at the edge of the table so that the blade may be tilted to form an acute angle with the stone. The arrow indicates the direction of the sharpening movement of the instrument along the stone.

the stone is not changed during the stroke. Another technique is to move the stone back and forth while maintaining a constant position of the instrument. The procedure for sharpening angle formers is essentially the same as that used for chisels, hatchets, or hoes except that allowance must be made for the angle of the cutting edge to the blade.

Gingival margin trimmers require more orientation of the cutting edge to the stone before sharpening than does a regular hatchet. The same principle of establishing the proper bevel angle and cutting edge angle is the criterion for instrument position before sharpening. It may be expedient to use a palm-and-thumb grasp when sharpening a trimmer with a 95- or 100-degree cutting edge angle (Online Fig. 23-3).

When single-bevel instruments are sharpened, a thin, rough ridge of distorted metal, called *bur* or *bur-edge*, collects on the unbeveled side of the blade. This bur is eliminated by a light stroke of the unbeveled side of the blade over the stone. This side of the blade is placed flat on the stone, and one short forward stroke is made. Burring can be kept to a minimum, however, if the direction of the sharpening stroke is against only the cutting edge of the blade, and the cutting edge does not contact the stone during the return stroke. The blade is touching the stone only on the forward sharpening stroke.

The amalgam knife or the gold knife has a thin blade tapering to the sharpened edge. A narrow edge bevel is present on both sides of the blade. In sharpening this instrument, only the edge bevels should be honed. If the entire side of the blade is worked each time, the thin blade soon disappears or becomes so thin that it fractures under the slightest pressure. To sharpen the amalgam knife or the gold knife, the blade is placed on the stone with the junction of the blade and shank immediately over the edge of the stone. The blade is tilted to form a small acute angle with the surface of the stone, and the stroke is straight along the stone and toward the edge of the blade only (Online Fig. 23-4). The sharpening is accomplished on both sides of the blade, with the stroke always toward the blade edge. This method produces the finest edge and eliminates any burs on the cutting edge.

The most difficult instruments to sharpen on a flat stone are the spoon excavators and discoid instruments. Only the rounded outside surface of the spoon can be honed satisfactorily on a flat stone, and this involves a rotary movement accompanied by a pull stroke to maintain the curvature of the edge. The spoon is placed on the far end of the stone and held so that the handle is pointing toward the operator. As the instrument is pulled along the stone toward the operator, the handle is rotated gradually away from the operator, until it is

pointing away from the operator at the end of the stroke. The instrument is picked up and placed at the far end of the stone, and the motion is repeated until the edge is honed. The stone may be placed on a flat surface or held in the hand for this procedure (Online Fig. 23-5). To hone the flat inside surface of the blade, a small cylindrical stone is passed back and forth over the surface (Online Fig. 23-6).

Other means of sharpening spoon excavators are achieved by using a grooved stone, mounted disks, or stones for use with a straight handpiece. A tendency exists, however, to remove too much metal when handpiece stones are used.

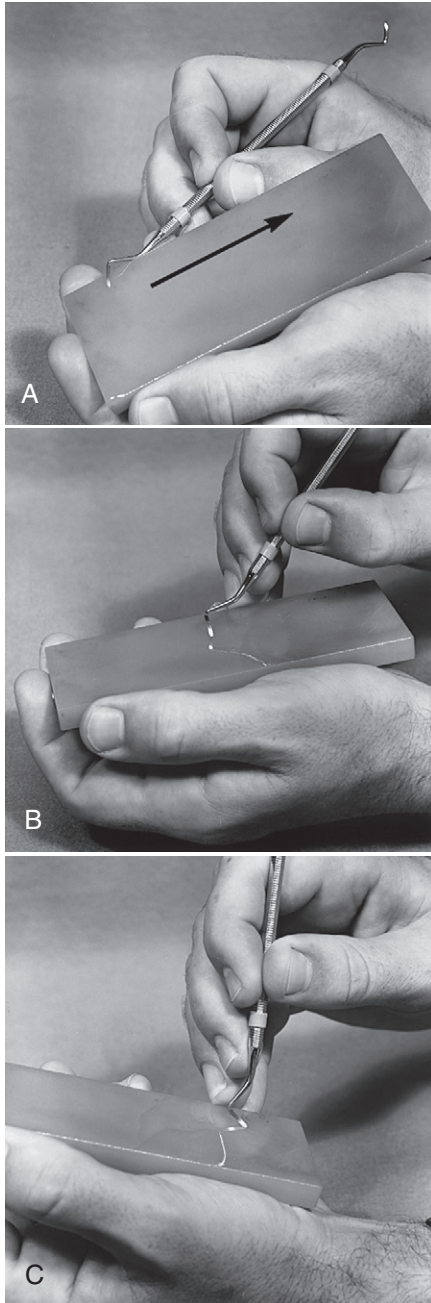
## Sharpness Test

Sharpness of an instrument can be tested by lightly resting the cutting edge on a hard plastic surface. If the cutting edge digs in during an attempt to slide the instrument forward over the surface, the instrument is sharp. If it slides, the instrument is dull. Only very light pressure is exerted in testing for sharpness.

The principles and techniques previously discussed provide sufficient background for the operator to use proper methods in sharpening other instruments not discussed here. It cannot be overemphasized that sharp instruments are necessary for optimal operating procedures. It also has been found prudent to have multiple tray setups so that a substitute instrument is available, if necessary, or substitute sterile instruments should be available so that other sterile tray setups are not disrupted when instruments are borrowed.

## Sterilization and Storage of Hand Cutting Instruments

Because hepatitis A and B viruses have been found in the saliva of infected persons, and evidence indicates that some dental personnel have acquired hepatitis B infections from patients, the importance of proper equipment and procedures for instrument sterilization must be emphasized. Sterilization in dental offices can be accomplished by autoclaving, dry-heat procedures, ethylene oxide equipment, and chemical vapor sterilizers. Boiling and chemical solutions (cold disinfection) do not sterilize instruments and should be considered as disinfection procedures only. The belief that only instruments that puncture or cut soft tissue or are exposed to blood should be sterilized and others only disinfected is no longer valid as a precaution against cross-infections. Aseptic techniques are



**Online Fig. 23-5** Sharpening a spoon excavator. **A**, Beginning of the stroke. **B**, Continuation of the pull stroke while rotating the handle in a direction opposite the stroke. **C**, Completion of the stroke and the handle rotation. Finger guides are used during the entire stroke, which is in the direction indicated by the arrow.

presented in other subject areas and are not detailed here. Sterilization procedures for operative dentistry are presented in Online Chapter 19. Storage of any hand cutting instrument should be in a sterile, wrapped tray setup or in an individual sterile wrapping.

## Effects of Sterilization

Methods of sterilization are sporicidal cold disinfection, boiling in water, autoclaving (steaming under pressure), use



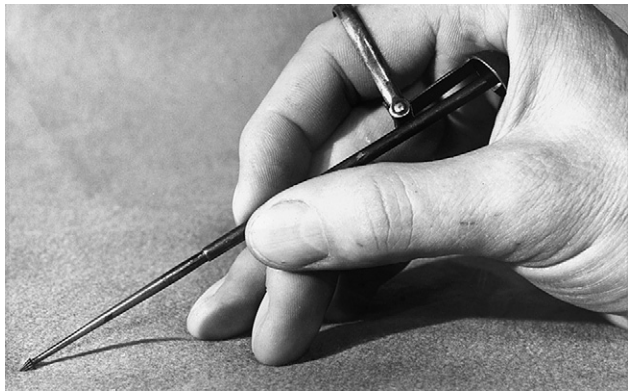
**Online Fig. 23-6** Use of a small cylindrical stone to hone the inside surface of spoon excavators and discoid-cleoid instruments. *Note:* Gloving is not illustrated in Figures 7-15 to 7-19 because sharpening is accomplished *after* sterilizing the washed instrument; after the instrument is sharpened, it is sterilized again.

of chemical vapor, and use of hot air (dry heat) (see Online Chapter 19 or details regarding acceptable methods of sterilization). Sterilizing carbon steel instruments by any of the first three methods causes discoloration, rust, and corrosion. Several methods for protecting against or minimizing these problems are available. One method used by manufacturers is to electroplate the instrument. This affords protection, except on the blade, where use and sharpening remove the plating. The plating also may pit or peel on the handle and shank under certain circumstances. A second method of protection is the use of rust inhibitors, which are soluble alkaline compounds. These usually are incorporated into commercial sporicidal cold disinfectant solutions, and special preparations are available for use in boiling water and autoclaves. The third method of minimizing the effect of moisture is to remove the instruments promptly at the end of the recommended sterilizing period, dry them thoroughly, and place them in the instrument cabinet or on the tray setup. Leaving instruments exposed to moisture for extended periods or overnight should be avoided.

Boiling in water and autoclaving for sterilization do not produce discoloration, rust, or corrosion of stainless steel instruments. Prolonged immersion in cold disinfectant solutions may, however, cause rusting. It is advisable to leave stainless steel instruments exposed to moisture only for the recommended time. Dry-heat sterilizers do not rust and corrode carbon steel instruments, but the high heat may reduce the hardness of the alloy, which would reduce the ability of the instruments to retain their sharp cutting edge. The choice of alloy in a hand instrument is left to the operator, but whichever alloy is selected to suit the immediate needs would soon prove unsatisfactory if proper manipulation and sterilization are not continually practiced.

## Powered Cutting Equipment Development of Rotary Equipment

The availability of some method of cutting and shaping of tooth structure and restorative materials is essential for the restoration of teeth. Although archeological evidence of dental treatment dates from 5000 B.C., little is known about the equipment and methods used then.<sup>1</sup> Early drills powered by hand are illustrated in Online Figures 23-7 and 23-8. Much of the subsequent development leading to present powered



**Online Fig. 23-7** Early straight hand drill for direct access preparations (circa 1800). The back end of the bur shank fits into a finger ring while the front end is rotated with the thumb and the forefinger.

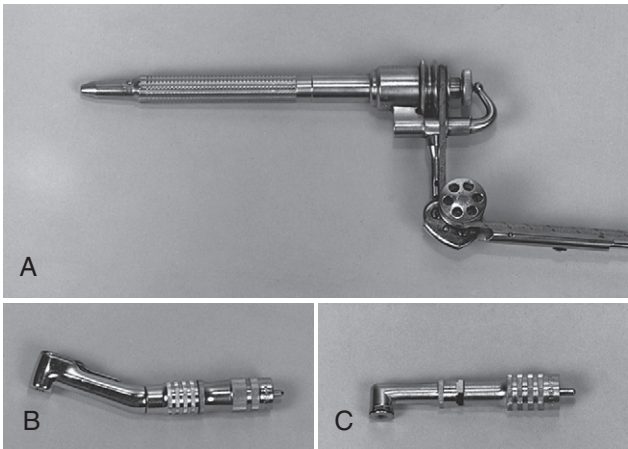


**Online Fig. 23-8** Early angle hand drill for indirect access preparations (circa 1850). The bur is activated by squeezing the spring-loaded handle.

cutting equipment can be seen as a search for improved sources of energy and means for holding and controlling the cutting instrument. This search has culminated in the use of replaceable bladed or abrasive instruments held in a rotary handpiece, usually powered by compressed air.

A handpiece is a device for holding rotating instruments, transmitting power to them, and for positioning them intra-orally. Handpieces and associated cutting and polishing instruments developed as two basic types, straight and angle (Online Fig. 23-9). Most of the development of methods for preparing teeth has occurred within the last 100 years.<sup>2</sup> Effective equipment for the removal (or preparation) of enamel has been available only since 1947, when speeds of 10,000 rpm (revolutions per minute) were first used, along with newly marketed carbide burs and diamond instruments. Since 1953, continued improvements in the design and materials of construction for handpieces and instruments have resulted in equipment that is efficient and sterilizable, much to the credit of manufacturers and the profession alike. Online Table 23-1 summarizes some significant developments of rotary dental equipment.

One of the most significant advancements was the introduction of the electric motor as a power source in 1874. It was incorporated into a dental unit in 1914.<sup>3</sup> The initial handpiece equipment and operating speeds (maximum of 5000 rpm) remained virtually unchanged until 1946 (Online Fig. 23-10).



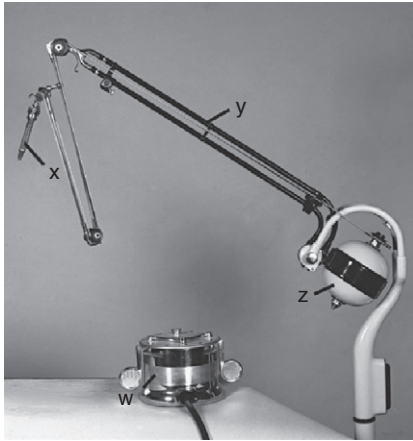
**Online Fig. 23-9** Conventional designs of handpieces. **A**, Belt-driven straight handpiece. **B**, Gear-driven angle handpiece that attaches to front end of the straight handpiece. **C**, Gear-driven angle handpiece designed for cleaning and polishing procedures.

Online Table 23-1 Evolution of Rotary Cutting Equipment in Dentistry		
Date	Instrument	Speed (rpm)
1728	Hand-rotated instruments	300
1871	Foot engine	700
1874	Electric engine	1,000
1914	Dental unit	5,000
1942	Diamond cutting instruments	5,000
1946	Old units converted to increase speed	10,000
1947	Tungsten carbide burs	12,000
1953	Ball-bearing handpieces	25,000
1955	Water-turbine angle handpiece	50,000
1955	Belt-driven angle handpiece (Page-Chayes)	150,000
1957	Air-turbine angle handpiece	250,000
1961	Air-turbine straight handpiece	25,000
1962	Experimental air-bearing handpiece	800,000
1994	Contemporary air-turbine handpiece	300,000

*rpm*, revolutions per minute.

The steel burs used at the time could not cut enamel effectively, even when applied with great force. With steel burs, increased speed and power resulted only in increased heat and instrument wear. Further progress was delayed until the development of instruments that could cut enamel. Diamond cutting instruments were developed in Germany around 1935 but were scarce in the United States until after World War II. In a 10-year period, starting in late 1946, cutting techniques were revolutionized. Diamond instruments and tungsten carbide burs capable of cutting enamel were produced commercially. Both instruments performed best at the





**Online Fig. 23-10** Typical equipment when an electric motor is used as the source of power: foot control with rheostat (w), belt-driven straight handpiece (x), three-piece adjustable extension arm (y), and electric motor (z).



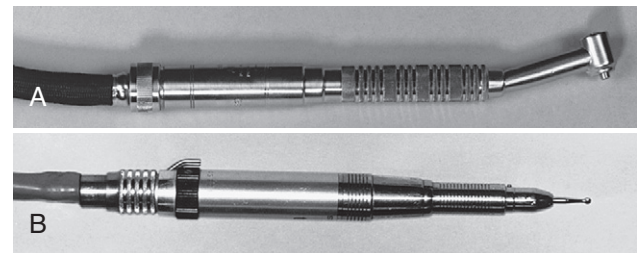
**Online Fig. 23-11** Page-Chayes handpiece (circa 1955). The first belt-driven angle handpiece to operate successfully at speeds greater than 100,000 rpm (revolutions per minute).

highest speeds available, and that prompted the development of higher-speed handpieces. Obtaining speeds of 10,000 to 15,000 rpm was a relatively simple matter of modifying existing equipment by enlarging the drive pulleys on the dental engine. By 1950, speeds of 60,000 rpm and greater had been attained by newly designed equipment employing speed-multiplying internal belt drives (Online Fig. 23-11).<sup>2</sup> They were found to be more effective for cutting tooth structure and for reducing perceived vibration.

The major breakthrough in the development of high-speed rotary equipment came with the introduction of contra-angled handpieces with internal turbine drives in the contra-angle head.<sup>4</sup> Early units were water driven, but subsequent units were air driven (Online Figs. 23-12 and 23-13, A). Although most current air-turbine handpieces (Online Fig. 23-14) have free-running speeds of approximately 300,000 rpm, the small size of the turbine in the head limits their power output. The speed can decrease to 200,000 rpm or less, with small lateral workloads during cutting, and the handpiece may stall at moderate loads.<sup>5</sup> This tendency to stall under high loads is an excellent safety feature for tooth preparation because excessive pressure cannot be applied. Air-driven handpieces continue to be the most popular type of handpiece equipment because of the overall simplicity of design, ease of control, versatility, and patient acceptance. The external appearance of current handpieces is similar to the earliest models.



**Online Fig. 23-12** Turbo-Jet portable unit (circa 1955). A small turbine in the head of the angle handpiece is driven by water circulated by a pump housed in the mobile base.



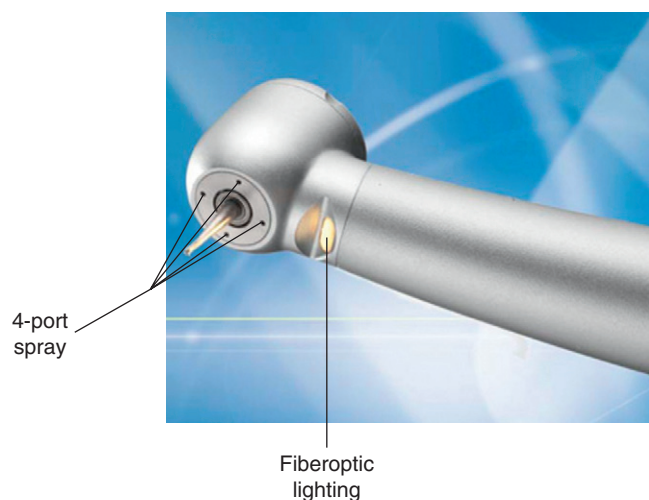
**Online Fig. 23-13** Air-turbine handpiece. **A**, The Borden Airotor handpiece (circa 1957) was the first clinically successful air-turbine handpiece. Current air-driven handpieces are similar in the basic design. **B**, Air-turbine straight handpiece (circa 1980).

The low torque and power output of the contra-angle turbines made them unsuitable for some finishing and polishing techniques, for which large heavy instruments are needed. The application of the turbine principle to the straight handpiece eliminated the necessity of having an electric engine as part of a standard dental unit. The design of the straight handpiece turbine provided the desirable high torque for low-speed operation (see Fig. 23-13, B).

Increasing concern about patient-to-patient transfer of infectious agents has put emphasis on other aspects of handpiece performance. Advancements in straight and angle handpieces allow repeated sterilization by several methods



**Online Fig. 23-14** Contemporary contra-angle air-turbine handpiece connected to the air-water supply line. (Courtesy of KaVo Dental Corp., Charlotte, NC.)



**Online Fig. 23-15** View of the handpiece showing four spray ports for cooling and fiberoptic illumination. (Courtesy of KaVo Dental Corp., Charlotte, NC.)



**Online Fig. 23-16** Electric handpieces and unit. (Courtesy of DENTSPLY International, York, PA.)

(see Online Chapter 19). Sterilization produces some damage to parts of the handpiece, however, necessitating more frequent service and repair. Other improvements of the angle handpiece include smaller head sizes, more torque, lower noise levels, and better chucking mechanisms. Since 1955, angle handpieces have had an air-water spray feature to provide cooling, cleansing, and improved visibility.<sup>6</sup> Most modern-angled handpieces also include fiberoptic lighting of the cutting site (Online Fig. 23-15). Electric handpieces that compete effectively with air-turbine designs have also been developed (Online Fig. 23-16).

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