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ROTARY CUTTING INSTRUMENTS: A LITERATURE REVIEW

Dr. Palak Arora*[1], Dr. Romil Singhal[2], Dr. Samarth Kumar Agarwal[3] and Dr. Kanchan Chaukiyal[4]

[1]Post Graduate Student Department of Prosthodontics and Crown & Bridge Kothiwal Dental College and Research Centre.

[2,3]Professor Department of Prosthodontics and Crown & Bridge Kothiwal Dental College and Research Centre.

[4]Post Graduate Student Department of Prosthodontics and Crown & Bridge Kothiwal Dental College and Research Centre.

***Corresponding Author: Dr. Palak Arora**

Post Graduate Student Department of Prosthodontics and Crown & Bridge Kothiwal Dental College and Research Centre.

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ABSTRACT

The introduction of rotary, powered cutting equipment was one of the truly major advances in dentistry. From the time of the first hand-powered dental drill to the present-day air-powered handpiece, tremendous strides have been made in the mechanical reduction of tooth structure, and thus in the ease with which teeth can be restored.

KEYWORDS: Rotary instruments, Powered cutting instruments and Recent advancements.

INTRODUCTION[1,2,3]

The removal and shaping of tooth structure are essential aspects of restorative dentistry. Initially this was a difficult process accomplished entirely by the use of hand instruments. The introduction of rotary, powered cutting equipment was one of the truly major advances in dentistry. Dental rotary cutting equipment has been developed in a largely ad hoc manner due to the lack of a theoretical understanding of its behavior influences an interrelationships of the factors involve dental rotary cutting could be elucidated, it would enable a rational and systematic approach to be taken in the design of improved equipment (both rotary cutting instruments and handpieces) and would allow more effective recommendations for equipment use to be made. Furthermore, it would then be possible to devise standard protocols for routine equipment testing and allow better methods of stating equipment specifications.

Classifications

According to MARZOUK[4]

There are three sets of instruments for tooth structure removal:

A) HAND CUTTING INSTRUMENTS.
B) ROTARY CUTTING INSTRUMENTS AND ROTARY ABRASIVE INSTURMENTS.
C) ULTRASONIC INSTRUMENTS

Rotary instruments

Rotary speed ranges[1]

1. **Conventional (3000-6000 rpm)**
2. **Medium High Speed (10000-20000 rpm)**
3. **High speed (20000-45000 rpm)**
4. **Ultra High Speed (> 100000 rpm)**

Low speed cutting instruments[1]

The crucial factor for some purposes is the surface speed of the instrument, the velocity at which the edges of the cutting instrument pass across the surface being cut. This is proportional to both the rotational speed and the diameter of the instrument, with large instruments having higher surface speeds at any given rate of rotation.

High speed cutting insturments[1,2]

At high speed, the surface speed needed for efficient cutting can be attained with smaller and more versatile cutting instruments. This speed is used for tooth preparation ration and removing old restorations.

Rotary cutting instuments design

Shank Design Shank design and dimensions vary with the handpieceThey are of three types:

- Straight handpiece shank
- Latch-type angle handpiece shank
- Friction-grip angle handpiece shank

Neck design

Neck is a intermediate portion of the instrument that connects the head to the shank. The neck normally tapers from the shank diameter to a smaller size immediately adjacent to the head. The main function of the neck is to transmit rotational and translational forces to the head.

Head design

Head is the working part of the instrument that performs shaping of tooth structure. The head of the instrument show greater variation in design. The shape of the head and material used to construct it are closely related to intended application and technique of use.

Bur blade design[1]

- The actual cutting action of a bur occurs in a very small region at the edge of the blade.
- Each blade has two surfaces-

– Rake face (towards the direction of cutting)
– Clearance face

- Three important angles:

✓ rake angle
✓ edge angle
✓ clearance angle

The rake angle is the most important design characteristics of a bur blade. For cutting hard, brittle materials, a negative rake angle minimizes fractures of the cutting edge, there by increasing the tool life.

Increasing the edge angle reinforces the cutting edge and reduces the likelihood for the edge of the blade to fracture. Carbide bur blades have higher hardness and are more wear resistant, but they are more brittle than steel blades and require greater edge angles to minimize fractures.

The clearance angle eliminates rubbing friction of the clearance face, provides a stop to prevent the bur edge from digging into the tooth structure excessively, and reduces the radius of the blade back of the cutting edge to provide adequate flute space or clearance space for the chips formed ahead of the following blade.

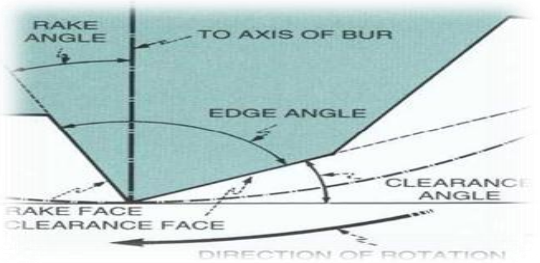

Fig : Bur design.

➢ **Head design**
Two Types

A) Bladed instruments
B) Abrasive instruments

Carbide burs, which were introduced in 1947, have largely replaced steel burs for tooth preparation. Steel burs now are used mainly for finishing procedures. Carbide burs perform better than steel burs at all speeds, and their superiority is greatest at high speeds. In most burs, the carbide head is attached to a steel shank and neck by welding or brazing. The substitution of steel for carbide in those portions of the bur where greater wear resistance is not required has several advantages.

Bur design

- As the effectiveness of small burs has increased, they have replaced larger burs in many procedures.
- Three other major trends in bur design are discernible:

1. **Reduced use of crosscuts,**
2. **Extended heads on fissure burs.**
3. **Rounding of Sharp tip angles.**

Diamond abrasive instruments

Diamond instruments for dental use were introduced in the United States in 1942 at a time before carbide burs were available and at a time when interest in increased rotational speeds was beginning to expose the limitations of steel burs. This second major category of rotary dental cutting instruments involves abrasion rather than blade cutting. Abrasive instruments are based on small, angular particles of a hard substance held in a matrix of softer material. Cutting occurs at numerous points where individual hard particles protrude from the matrix, rather than along a continuous blade edge.

Parts of diamond instruments

Diamond instruments consist of three parts:

✓ Metal blank [Blank resembles a bur without blades, having head, neck and shank
✓ Powdered diamond abrasive
✓ Metallic bonding material that holds the diamond powder onto the blank.

Diamond Grit Sizes

Code	Description	µ
SF	Super Fine	30
F	Fine	50
M	Medium	107-120
C	Coarse	150-180
SC	Super Coarse	180-250

Fig: Diamond grit sizes.

Role of rotary instruments in prosthodontics[7]

The preparation of teeth to receive cast metal or ceramic restoration does not require an extensive armamentarium. The excavation of caries should be accomplished with sharp spoon excavators and round burs (no. 4 or no. 6) mounted in a contra-angle handpiece. Hand chisels may be used to accentuate the facial and lingual walls of proximal boxes. All other procedures.

usually are accomplished with a high-speed air turbine handpiece. Small diamond points, used with a water-air spray in a high-speed handpiece, will remove precisely controlled amounts of tooth structure. The surface that remains can be easily smoothed. There is no indication for the use of large diamond cutting discs in low-speed contra-angle or straight handpieces. They frequently overextend preparations, and their potential for injury tothe patient is great. It is important that the cavosurface finish line be smooth and continuous to facilitate the fabrication of restorations with well-adapted margins. Gross reduction is most efficiently accomplished with coarse diamonds.

❖ **Laboratory burs**
- ✓ They have longer shank and bigger heads
- ✓ Used in slow speed handpiece
- ✓ Most commonly used burs :acrylic burs
- ✓ Used for cutting and polishing of acrylic

- **Mandrels**
- ✓ Rods of various lengths used in low speed
- ✓ handpiece
- ✓ Abrasives can be permanently attached or
- ✓ separate
- ✓ **Shanks:** latch; friction grip; straight
- ✓ **Attachments:** snap-on;screw;pin-design
- ✓ **Attachments**

1. sandpaper discs:
- ✓ Used to polish and finish restorations
- ✓ Abrasives like garnet, sand, emery and cuttlefish are
- ✓ Used

2. carborandum disc
- ✓ Also called separating disc or Jo-dandy disc
- ✓ Double sided
- ✓ Green-gray or dark colors
- ✓ Fast cutting of metal castings, cast gold, porcelains, acrylics, and tooth structure.

Diamond disc
- ✓ Diamond particles bonded to metal structure
- ✓ Used to trim porcelain.

Stones
- ✓ Used for cutting, polishing metal, amalgam
- ✓ gold, porcelain restorations in laboratory
- ✓ The abrasive material include garnet, aluminium
- ✓ oxide, silicon carbide
- ✓ Used at slow speeds
- ✓ White stones have finer grit than green.

Rubber wheels and discs
- ✓ The matrix can be phenolic resins or rubber
- ✓ Abrasive can be sintered or resin bonded
- ✓ Softer and less wear-resistant
- ✓ Used for finishing and polishing for metal
- ✓ restorations
- ✓ Conforms to the surfaces like grooves

- **Robinson's brushes**
- ✓ Robinson brushes (stiff, medium, soft) are used with pumice or tripoli.
- ✓ Slow speed with pressure produces greater cutting potential.
- ✓ high speed with light pressure produces a high-lustre finish.

Chamois wheels
- ✓ Chamois wheel are used only with dental rouge and give a luster to the casting and dentures.

Advancements in rotary instruments

Advancements

The high speed handpiece is a precision device for removal of tooth tissue efficiently and rapidly with no pressure, heat or vibration and cut the tooth like butter. However these handpieces have to be used with caution. Smoother surfaces have replaced the rough textures of older handpiece designs eliminating areas that may trap bacteria and debris. Manufacturers have also minimized the seams between the outer casing segments aiding in the process of sterilization. Chrome-plated outer sleeves have been replaced with titanium providing a more durable finish. The finish is less sensitive to the chemicals used during disinfection that may lead to corrosion. When considering an electric handpiece, titanium also provides an ultra light handpiece which may be a concern. Electric handpieces are larger at the connector and therefore heavier then their air driven counterparts. Titanium handpieces can demonstrate a 30% decrease in weight compared to chrome-plated handpieces.

Slim-form ti-max X450 handpiece[8]

The slim-form Ti-Max X450 series possesses a unique 45 degree head specially designed to access hard -to-reach areas for sectioning and extraction of thied molar and other impacted teeth.

Comfort drive handpiece

Comfort drive feature precise cutting performance in a lighter, shorter and quieter handpiece making it the most innovative high-speed ever.
- ✓ Precise Performance.
- ✓ Superior comfort.
- ✓ Seamless Intergration

Ti-max z contra angle handpiece

Introducing NSK Ti-Max Z the most durable, high performance handpiece series in its class ever offered by anyone, anywhere. NSK Ti-Max Z series handpieces perform at a remarkably low noise level with virtually no vibration, have a solid titanium body with Duracoat scratch resistant surface and feature the smallest head and slimmest neck dimensions in the global market allowing operational visibility like never before.

Hazards caused by cutting instruments
- Airborne Contamination
- Hand-to-Surface Contamination
- Cross-Infections

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