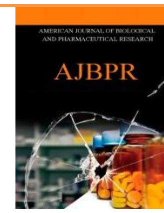
e- ISSN - 2348-2184
Print ISSN - 2348-2176

AMERICAN JOURNAL OF BIOLOGICAL AND PHARMACEUTICAL RESEARCH

Journal homepage: www.mcmed.us/journal/ajbpr



HIGH SPEED DENTAL TOOLS IN DENTISTRY- A REVIEW

Ahmad Naeem*, Mohamed Mohsen Abuzenada Basem, Alsharif Abdulmohsin Al-Ghalib Thamer, Adel Helmy Ahmed Ali Mai, Elhomossany Mahmoud**

* Associate Professor, Division of Removable Prosthodontics, Department of Clinical dental sciences, Batterjee Medical College of science & technology, Jeddah, Saudi Arabia.
** Assistant Professor, Faculty of Dentistry, King Abdulaziz University, Jeddah / Head of Program, Division of Conservative Dentistry, Department of Clinical dental sciences, Batterjee Medical College of science & technology, Jeddah, Saudi Arabia.
*** Medical Director, Division of Removable Prosthodontics, Department of Clinical dental sciences, Batterjee Medical College of science & technology, Jeddah, Saudi Arabia.
**** Head of Division, Division of Removable Prosthodontics, Department of Clinical dental sciences, Batterjee Medical College of science & technology, Jeddah, Saudi Arabia.
***** Assistant Professor, Division of Removable Prosthodontics, Department of Clinical dental sciences, Batterjee Medical College of science & technology, Jeddah, Saudi Arabia.

Article Info

Received 29/05/2018
Revised 16/06/2018
Accepted 19/06/2018

Key words: -Burs, rotary, speed, water, spray, diamond points.

ABSTRACT

A clinical expertise behind the use of sharp hand and rotary instruments requires ability and coordination gained only through extensive training. For the performance of detailed dental procedures, the clinician must possess adequate knowledge behind the application of dental instruments. During clinical practice, the dentist operates on oral tissues within the oral cavity where even one mm discrepancy is crucial behind success & failure. The present article reviews the role of high speed instruments used in Dentistry and their regulatory mechanisms.

INTRODUCTION

In the initial days, tooth structure removal was done using hatchets, sharp-edged chisels and hoes. These hand held cutting instruments were used for removing under-mined & un-supported enamel resulting from dental caries. These methods were time consuming and often pose difficulty.

Fortunately for both dentists and patients, there have been many advancements to the design and drive mechanisms of dental hand pieces since pre-historic times. Pierre Fauchard mentioned the use of bow drill to complete root canal procedures in his book titled 'e Chirugien Dentiste ou Traite des Dents' published in 1728. It was believed to be the first dental tool to facilitate removal of bits of teeth without chipping them away by hand. Not much happened to improve the technology further till 1864, when a British dentist George Harrington invented a clock work type of drill named Erado. This hand piece was much faster than hand operated drills and provided about 2 full minutes of working time before the spring had to be re-wound. In 1868, advancement was made in the form of a pneumatic drill operated by pedal-power. The pedal-operated offered control over how fast the bur to spin in its head [1].

In 1953, an ultrasonic method of tooth tissue removal was also introduced, which used suitably shaped tips vibrating at frequencies ranging from 250,000 to

Corresponding Author

Naeem Ahmad
Email:- naeem.ahmad@bmc.edu.sa

3,00,000 cycles – per seconds. The introduction of air-bearing hand piece in the early 1950's made possible greater rotational speeds of approximately 500,000 rpm. In modern dentistry, the dental hand piece has continued to evolve. Variations towards use of water and air lines to electronical based designs for comfort. These minor changes have been aimed at attempting to stifle noise, lessen vibration, and minimize heat output. By making the unit smaller, the device is more comfortable in the professional's hand and the patient's mouth. It is only recently around 30 years, this hunt has slowed down but still the dental profession is trying to refine the instruments & procedures as much as possible within the human dexterity [2].

Literature Review: An extensive research was done in Pubmed and Scopus databases from 1970 till 2018 using following mesh words like rotary, speed, water, spray, diamond points, burs and a total of 88 articles were found. Out of which 13 articles were finally selected, analyzed and summarized as per the relevance to constitute this review article.

A dental hand piece is a vital tool in dental practice that performs functions like removal of tooth decay, tooth preparation and finishing & polishing of dental restorations. The first known air rotary hand piece was manufactured in 1868 by Green. Later on in 1873, electric hand piece technology evolved & it completely revolutionized dental treatment. The modern air turbine hand pieces were introduced by Borden in 1957 capable of ultra-high speeds up to 300,000 rpm. Nowadays in North America, majority of clinical procedures in various pre-doctoral programs are performed using these high-speed hand pieces. For pre-clinical training, usually low-speed hand pieces are preferred as they provide the students a preliminary tactile sense [3].

So it is seen that continuous development of newer methods till 1960 indicated that the earlier instruments had some or the other kind of disadvantage. In spite of the introduction of numerous tooth reduction instruments & procedures, the objectives & principles remained the same. The operator must remove minimal amount of tooth tissue, cause least injury to the periodontal tissues and pulp & with provide least discomfort to the patient. So it is seen that the most popular type of hand pieces are still the Air driven hand pieces because of the simplicity of design, ease of control and more patient acceptance [3].

Gear driven types: These are one of the oldest and largest group of hand pieces and generally the conventional type. Three standard designs based on use a straight hand piece, contra angle hand piece and prophylaxis hand piece. Rotary power is transferred to the straight hand piece by a belt that runs from an electric over a series of pulleys and a three pieces extension cord arm. Rotary cutting instruments are inserted in to a chunk at the front of the hand piece. Conventional hand pieces operate at speeds under 5,000 rpm. Many now have improved bearing surfaces that allow greatly increased speeds. A long contra angle design helps to reduce amount of vibration. It is possible to obtain speed of 100,000 rpm with a gear driven angle hand piece that has an automatic lubricating system. The most recent addition of the gear driven type of hand piece is addition of a miniature electric motor.

Water driven types: Hydraulic driven turbine hand piece came into use in 1953 operating at a speed of around 60,000 rpm. The first commercial model known as Turbo-Jet operated at a speed of 10,000 rpm. Water was supplied to the hand piece through inner small plastic tubing under high pressure to rotate turbine located in the head. Simultaneously the larger outer tube used to return water to the reservoir.

Air-driven hand pieces: These operate using a compressor to produce compressed air that drives the turbine of the hand piece containing bearings and O-rings. There is a chuck mechanism to hold the burs while rotating during use it utilizes either a friction grip or a push-button mechanism.

Electric hand pieces: Electrically driven hand pieces operate using a simple electricity supply to power the electric motor through a control unit. These operate at a minimum speed of 20 rpm and up to 200,000 rpm, depending on the specific hand piece and attachments used. Electric hand pieces use a motor, so the attainable rpm is primarily determined by the motor attachment used [4].

Hybrid hand pieces: A hybrid hand piece has been introduced in the recent years that work on both air-driven and electrically driven hand pieces. This hybridization has resulted in a hand piece with some of the benefits found in both categories of traditional Hand pieces [4].

The field of Dentistry is moving at a rapid pace towards electrical hand pieces. For this quick shift, we must have enough evidence supporting the use of electrical over air-turbine hand pieces. **Choi et al in 2010** compared the cutting efficiency of an electric hand piece and an air-turbine hand piece using various materials commonly used in dentistry and found that electric hand piece is more efficient at cutting various materials used in dentistry than the air-turbine hand piece.

Speed variability: The cutting efficiency of burs depends not only on the speed of rotation but also on the size of sintered abrasive particle, no. of sintered abrasive particles, shape of sintered abrasive particles, pressure applied by sintered abrasives on tooth surface & the time elapsed between the contacting surfaces. Since 1946 continues increases in operating speeds have given rise to large number of contradictory and confusing definitions of the various speeds available. There speed ranges are generally available low or slow speeds (below 6000 rpm) medium or intermediate speeds (6000 to 100.000 rpm) and high or ultra-high speeds (above 100,000 rpm).

Low speed: It is no longer used for cavity preparation except for operations such as cleaning the teeth excavating caries, refining cavity preparations marinating gold restorations. Range is within 6000rpm.

Medium speed: The range is between 6000 to 100,000 rpm. It is used for cavity preparation, finishing procedures such as placement of retentive grooves and bevels [5].

High speed: The range is above 100000 rpm. It is used for clinical procedures like removing old restorations and reducing cusps.

Rationale of increased speeds: Although tooth structure can be removed by an instrument rotating at low speeds. It is a traumatic experience for both. The patient and dentist low speed cutting is in effective and time consuming and requires relatively heavy force of application of 2 to 4 pounds. This results in heat formation. The main reason for increasing the speed of rotating instruments is to increases its cutting efficiency. The operator has better control and greater ease of operation. Instruments last longer. Patient is generally less apprehensive because annoying vibrations and operating time are decreased. Several teeth in the same arch must be treated at the same appointment [6].

At the same time, the increased speed creates increased temperatures in the tooth. Therefore cooling the tooth is required to prevent pulpal damage. When a dentist changes from the lower speeds to higher speeds, he must develop a new tactile sense to avoid over cutting. The end finishing is better accomplished using moderate speeds with finishing burs with fine gritted abrasives.

Types of high speed instruments: Hand pieces can be divided into four types depending upon their speed limits; Low speed - up to 10,000 rpm; Intermediate speed - 25,000 to 45,000 rpm; High speeds - 50,000 to 100,000 rpm; Ultra high speeds - 100,000 rpm [7].

Heat generation: The rotating cutting tools come in contact with the tooth surface and the heat is generated. It was not until 1930 that the workers began to investigate the heat rise in the dental pulp. It has been found that the temperature rise develops within 10-12 seconds, after the cutting operation is started.9 Hudson and associates in 1954 conducted a study on temperature developed in dental cutting instruments from their study they have concluded that the temperatures resorb by dental burs in cutting human dentin ranged from 125°F to 275°F. Hence it is advisable to use some form of coolant. The amounts of heat transferred to the tooth from the bur decreases, at speeds above 12000 rpm & trauma to pulp is minimized.

Coolants: Every means should be employed to keep the temperature down as much as possible during cutting operations. There are three types of coolants usually employed in dental practice like water, spray of air and water & air alone.

Peyton has shown that at speeds ranging from 30,000 rpm to 170,000 rpm and with an application of four ounces of pressure a temperature rise within the tooth of less than 15°C occurred when water or air-water sprays were employed. He also found that even with a water coolant, excessive temperatures developed, when large diameter instruments or excessive pressure were applied with increased operating speeds. This indicates that the only the use of coolant is not sufficient to reduce the danger of temperature rise. There are certain other issues with high speed hand pieces which needed to be considered. Most of the hand pieces are designed with a spray of water to be directed from the head of hand piece directly onto the cutting surface. Sometimes, the abrasive on cutting tool is away from the stream of water, so the coolant does not flood the tooth surface being cut, resulting in temperature rise. To overcome this difficulty perforated disks have been developed. In situations where non-perforated disks are to be used, the speeds must be within 10,000 rpm. Another added advantage of coolant lies in its role to flush away the tooth debris produced during tooth cutting preventing the clogging of cutting blades/surface hence maintaining cutting efficiency of the stone. Nelson recommended the addition of a wetting agent to the water spray [8].

Vibration: Most patients associate the sensation of vibration, noise, pressure and the slight increase in cutting temperature with the sensation of pain. Hence these trigger factors must be kept to minimal.

Cross contamination by Ultra-speed cutting tools: Atmospheric microbial contamination from air turbines has been an area of concern for the public health community since ages. Recent studies suggest that the extent of aerosol produced by air turbine may reach hazardous levels of microbial population. A report was published about pulmonary tuberculosis patients, during tooth preparation procedures; the heaviest concentration of bacilli was reported at 02 feet in distances from the patient's mouth.

This indicates that the dentist and his assistant are exposed to a serious health hazard when operating with an ultra-speed exposed instrument on patients having such pathogens in their oral flora.

Infection control is very important in dentistry. Both dentist and patients are at risk of communicating diseases during treatment procedures. Dental burs have been identified as a source of cross-contamination between patient and dental personnel. Autoclave and Hot air oven was found to be the relatively best method to sterilize burs. Hence proper cleaning and sterilization of dental burs must be strictly carried out to prevent cross contamination in clinical practice.

Patient's medical history is of utmost importance. If there is evidence of diseases like tuberculosis, pneumonia, influenza, infections hepatitis or any infectious diseases including the common cold, a double protective face mask should be worn both by the dentist and the dental assistant. Alongside, protective eye-glasses must be routinely worn. We can also go for intraoral disinfection by asking for a mouth rinse for every patient before treatment to reduce the microbial load [9].

Biological response to high speed tools:

Dentin: dentin removal leads to a reaction in dental pulp which may lead to dentinal changes. Fish in 1932 conducted an experimental investigation into the effect of cavity preparation on dentin and pulp. He found that in some cases there was sclerosis of the cut dentinal tubules which formed a protective sealing over the pulp from the injury and there is a growth of tubular dentin. These reactions are produced by the stimulation of the odontoblasts. Other reaction resulted in formation of dead tracts. On the pulpal aspect of these tubules, secondary dentin is laid down which also seals pulp.

Pulp: Pulp changes associated with tooth reduction were studied by **Marsland & Shovelton [8] in 1970.** The changes found were no severe than those produced at lower operating speeds provided that adequate cooling of the cutting instrument by water jet or air/water spray is ensured. The enamel showed minute cracks and dentin showed altered staining reactions as a result of localized overheating. Immediate damage to the dental pulp was greater in air-cooled than water-cooled specimens and this greater degree of injury was evident up to 15 days post-operatively. The young, uninfected, dental pulp has a very considerable potential for repair following injury.

Discussion: For efficient use of cutting tools, certain factors should be considered. Heat generated during tooth tissue removal must be kept to the minimum. Use of efficient coolants, not only eliminate the heat generated, but at the same time, keeps the operating area clean and free of any debris.[9] High speed cutting tools reduce the working time hence less patient annoyance. When the factors of pressure, temperature and vibration are kept within the patient's tolerance limits, the comfort is improved. Oversized cutting tools should be avoided, as they are difficult to control and at the same time, the accuracy of tooth preparation on procedure is also adversely affected.

Grajower & Zeitchick [9] in 1979 studied the grinding efficiency of diamond burs and established that the deterioration of round diamond burs during 08 minutes of operation was found to be more pronounced for burs with low particle densities than for burs with high particle density. Hence we must use high particle density burs for longivity.

Isik et al [10] in 2010 compared the caries removal efficiency of polymer burs (Smart burs) and conventional carbide burs microbiologically and found that polymer burs were as effective as conventional carbide burs microbiologically in caries removal.

Borges et al [11] in 1999 found that conventional diamond burs show several limitations such as decrease in cutting effectiveness due to repeated sterilization and a short lifetime. An additional shortcoming of these diamond coaved dental burs is their potential to release of Ni+2 ions from the metallic binder into the body fluids.

Abirami et al [12] in 2011 & **Sangameshwar et al [13] in 2014** did a study on the evaluation of efficiency of different decontamination methods of dental burs and emphasized on the importance of infection control in dentistry because of concern over communicable diseases transmitted during the various invasive and noninvasive dental procedures. Both dentist and patients are at risk of communicating diseases during treatment procedures. Instruments must be cleaned, disinfected and sterilized to prevent any contamination. Dental burs have been identified as a source of cross-contamination between patient and dental personnel. They are contaminated with necrotic tissues, saliva, blood and potential pathogens during use. A strict sterilization protocol is essential as the risk of cross-infection is higher in prosthodontics next to maxillofacial surgery. To achieve sterilization of any instrument, three definite stages are to be complete; first is the pre-sterilization cleaning, next is the sterilization process and at last the aseptic storage.

Faruk E et al [14] in 2018 studied the frequency of changing diamond burs and found that the diamond burs wear after multiple usage and they must be changed after every 05 tooth preparations. A diamond bur must not be used for tooth preparations after try-in procedures of metal or zirconia substructures.

CONCLUSION: For the proper usage of these high speed cutting devices, a thorough understanding of their mechanism along with their interaction with the biological integrity of teeth is mandatory. It is only then that these devices will act as a boon to dentistry. To conclude, for effective tooth preparation, a balance must be maintained between the size of abrading particle, its shape, pressure applied by the hand piece, speed of rotation & time of application. Considering these technological advances in the latest generation of dental burs and hand pieces, the clinician must select the hand piece and bur that meets the daily demands of clinical practice, hence increasing both the efficiency and patient satisfaction. In the present review, a critical evaluation of high speed cutting devices along with their biologic reactions to dentin and pulp have been briefly discussed.

Source of support: Nil **Conflict of interest:** None

REFERENCES

1. Shannon Pace Brinker. A Critical Tool of Everyday Dentistry - the History and Necessity of Dental Hand pieces. https:// contemporary productsolutions.com/wp-content/uploads/ Schein _11_ 14_ Handpiece_ History. pdf
2. Vinski I. (1979) Two hundred and fifty years of rotary instruments in dentistry. *Br Dent J*, 146, 217-23
3. Siegel S, Fraunhofer J. (2000) Irrigation rates and hand pieces used in prosthodontic and operative dentistry: results of a survey of North American dental school teaching. *J Prosthodont*, 9, 82-6
4. David L. Hand pieces and Burs: The Cutting Edge. ADA / CERP; Penwell. www.ineedce.com.
5. Choi C, Driscoll F, Romberg E. (2010) Comparison of cutting efficiencies between electric and air-turbine dental hand pieces. J *Prosthet Dent*, 103, 101-7
6. Roberson T, Heymann H, Swift J. (2002) Sturdevant's Art & Science of Operative Dentistry, 4th edition, Mosby Inc.
7. Janota M. (1973) Use of scanning electron microscopy for evaluating diamond points. *J Prosthet Dent*, 29, 88-93
8. Marsland A, Shovelton S. (1970) Repair in the human dental pulp following cavity preparation. *Arch Oral Biol*, 15, 411-23
9. Grajower R, Zeitchick A, Rajstein J. (1979) The grinding efficiency of diamond burs. *J Prosthet Dent*, 42, 422-8
10. Isik E, Olmez A, Akca G et al. (2010) A microbiological assessment of polymer and conventional carbide burs in caries removal. *Pediatric Dent*, 32, 316-23
11. Borges M, Magne P, Fender E et al. (1999) Dental diamond burs made with a new technology. *J Prosth Dent*, 82, 73-8
12. Abirami M, Saisadan D, Manimaran P et al. (2017) Evaluation of Efficiency of Different Decontamination Methods of Dental Burs: An In vivo Study. *Pharm Bio allied Sci*, 9, 37-40
13. Sangameshwar S, Deepa H, Megha K et al. (2014) Decontamination Methods Used for Dental Burs-A Comparative Study. J Clin Diagn Res, 8, 39-41
14. Faruk E, Simel A, Cem S. (2018) What is the changing frequency of diamond burs? *J Adv Prosthodont*, 10, 93-100.