Evolution and Mechanism of Dental Handpieces

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Abstract- The dental handpiece of today is a sophisticated combination of precision parts moving in perfect synchronization at extremely high speed. A handpiece is a device for holding rotating instruments, transmitting power to them, and for positioning them intraorally. A dental handpiece is fundamental tool in dentistry. A dental handpiece has literally shaped the dentistry as we know it. Today's clinician is extremely dependent on the handpiece to sustain a smooth-running practice. The handpiece is an incredibly sophisticated device that requires a diligent maintenance protocol to keep it running properly and safely. The leap from belt driven to air driven hand piece was a major breakthrough because it overcame slow speed, time spent on tooth preparation, pressure and vibration of belt driven handpieces. Dentistry has seen the development in cutting tools from 5000rpm - 300000rpm. Initial days of low-speed turbine arm to high-speed handpiece and then electric and laser handpieces.

Introduction:
Enamel, found in human teeth, is the body's toughest tissue. This type of tissue is found in teeth because it can endure strong occlusal stresses and shield the tooth's interior.[1] One of the most important parts of restorative dentistry is the contouring and removal of tooth structure. At first, this was a challenging procedure that could only be completed with manual instruments. One extremely significant development in dentistry was the introduction of powered, rotating cutting equipment. Significant advancements have been made in the mechanical modification of tooth structure and in the ease with which teeth can be cleaned, starting with the invention of the first hand-powered dental drill and continuing to the current air-powered handpiece. Tooth preparation no longer requires the use of numerous hand instruments thanks to high-speed, modern equipment. Nevertheless, hand devices continue to be a vital component of the toolkit for high-quality restorative dentistry.

The early hand-operated devices were heavy, unwieldy, and inefficient in many circumstances due to their huge, heavy handles and inferior (by today's standards) metal alloys in the blades. Neither the nomenclature nor the manufacturing processes were uniform.[2] In this review article we discuss about evolution, classification and mechanism of dental handpieces.

Background:
Little is known about the tools and techniques utilized, despite the fact that dental therapy was evident as early as 5000 BC based on archeological findings. The round, hard tube, which resembled a drinking straw and was first made of jade and then copper, was used by the Mayan people. It was spun between the hands or in a rope drill and used an abrasive slurry of powdered quartz mixed with water to cut a perfect round hole through the enamel.[3,4,2] Fauchard created his own bow drill to penetrate natural tooth enamel. When mechanical hand drills were first developed in the early 1800s, they could only rotate at a rate of 15 revolutions per minute. The British dentist George Harrington made one of the earliest significant breakthroughs in 1864. He created the Erado, a clockwork dental drill. When it comes to mechanically operated dental drills, noise has always been a big drawback.[2,5,6] Dr. George F. Green received the first patent for an electric dental drill in 1875. James Beall Morrison's invention of the foot treadle drill in 1870 completely changed the field of dentistry. A flexible cable arm connected the electric dental engine to the handpiece in 1883. This marks the initial instance of utilizing a power source other than human hands and feet for cutting Dr. C. Edgar Kells invented a patented electric control panel in 1887, to which a motor-driven hand piece could be connected.[3,2,7] In 1910, a jointed engine arm with a belt-driven hand piece became available. John Patrick Walsh invented the air turbine handpiece, which is the dental drill used today. In 1955, the Page-Chayes, an electric motor-powered angle handpiece with belt drive, achieved successful speeds of 100,000 rpm. The first air-driven turbine hand piece with clinical success was introduced in 1956 and could reach speeds of about 300,000 revolutions per minute. It was presented by John Borden, MD. In 1994, the modern air turbine handpiece was unveiled.[2,8,9] The majority of what we now consider standard restorative dentistry was made possible by advancements in handpieces the newest of which are the fibre optic handpieces.[2,9]
Classification of handpieces:[2,9] (figure1)

1. Depending on speed
   
   Sturdevant classification:
   - Low or slow speeds (less than 12,000rpm)
   - Medium or intermediate speeds (12,000 – 20,000 rpm)
   - High or ultra high speeds (more than 200,000 rpm)

   Marzouk classification:
   - Ultra-low speed - 300 -3000 rpm
   - Low or slow speed- 3000 -6000 rpm
   - Medium or intermediate speed - 20,000 – 45,000 rpm
   - High speed- 45,000 – 1,00,000 rpm
   - Ultra high speed – more than 1,00,000 rpm

2. Depending on mechanism of operation
   - Gears, water, belts, or air driven

3. Depending on Head design - Standard, Mini, Torque

4. Depending on the angles
   - Straight - Right angled -Contra angled

5. Depending on the motor
   - AIRTURBINE, AIR MOTOR

6. A color-coded ring indicates;
   - Red = speed increase
   - Green = speed decrease
   - Blue = no change in speed

7. Depending on the sort of bur holding
   - Airmatic bur changer
   - Screw type chuck
   - Ultrapush system

**Mechanism:**

Handpieces classified based on their mechanism[10,11,2]

- Air driven
- Electric driven

Air driven can be divided into[10]

- Swash plate principle
- Rotary vane principle

Swash Plate principle – Driven by a sequence of pistons pressing against a disk, the piston presses against the plate and rotates it as it rises. The next piston in the sequence takes over and keeps turning the disc when the current piston reaches the end of its trip. Air is fed to the pistons progressively by the rotary wave created by the disc's revolution.[10,13]

Electric driven – The majority of these motors run on direct current and have an armature housed inside a permanent magnet assembly. Their performance is dependent on 1) The structure and strength of the magnetic field 2) The type and quantity of armature coils.

The motor's speed can be adjusted by changing the distance between the magnets and the rotating armature. The smoother and less jerky the motors performance, the more armature coils they have.[10,14,15]

Air turbine - An impeller, two rings, a spindle/chuck assembly, and two tiny bearings make up a hand piece turbine. The central rotating component that provides rotary motion to the impeller is called the shaft, and it is often press-fitted into the device. Small wedge lock mechanisms that are intended to firmly hold a dental bur are located inside the spindle. The hand piece head contains the entire turbine assembly.[16,17]
Constant Speed and Torque: An air-driven handpiece rotates between 300,000 and 350,000 revolutions per minute, but it cuts at 180,000 to 200,000 revolutions per minute when it is under strain. A handpiece that runs on electricity runs at 200,000 revolutions per minute. When cutting through crowns or other dense materials, the air-driven handpiece's stalling or slowed speeds are eliminated by the electric handpiece's steady torque. It is necessary for all of us to acquire the skill of cutting tooth structure with a feather touch.

Concentric Cutting: As speed is maintained, the constant torque creates a concentric cutting action. The feather design offers metal, porcelain, amalgam, and tooth structure removal incredibly quickly.

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Fibreoptic Standard Head Mini head (Figure 1) Contrangle Straight

Electrical Handpiece (Figure 2)