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APPLICATION OF ULTRASONIC TECHNOLOGIES IN ORTHOPEDIC DENTISTRY

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Abstract
Ultrasonic technologies, introduced in dentistry since the mid-20th century, have revolutionized various dental procedures, including periodontitis treatment and dental plaque removal. Ultrasonic devices used in dental practices typically consist of piezoceramic, magnetostrictive, or aerodynamic transducers that operate within a frequency range of 20-45 kHz. In orthopedic dentistry, ultrasonic tools have proven highly effective for minimally invasive preparation of dental tissues, ensuring precision and reducing trauma to both hard and soft tissues. This review explores the application of ultrasonic technologies in orthopedic dentistry, including the benefits, mechanisms, and clinical uses in procedures such as the removal of dental restorations, condensation of cements, and physiotherapeutic treatments. It also examines the advantages of specific tools used for precise preparation in aesthetically significant areas, the management of implants, and de-cementing crowns and bridges. The paper highlights advancements in ultrasonic instrumentation that improve the functionality, longevity, and aesthetic outcomes of indirect restorations.

Keywords: ultrasound, methods of application, orthopedic dentistry.

Introduction

Ultrasonic technologies have been employed in dentistry since the mid-1950s, initially for the treatment of periodontitis and dental plaque removal. The equipment utilized for these procedures typically features piezoceramic, magnetostrictive, or aerodynamic transducers, which produce longitudinal vibrations at frequencies between 20-45 kHz and an amplitude of 6-100 μm.

Magnetostrictive and piezoceramic ultrasonic wave generators are widely used in medical applications. Magnetostriction refers to changes in the size and shape of a crystalline body under the influence of magnetic fields, a phenomenon discovered in 1842 by Joule in ferromagnetic metals and alloys. In dentistry, magnetostrictive transducers consist of an inductance coil and a core. When an alternating electric current is applied, oscillations occur through electromagnetic induction, which are transmitted to a waveguide and ultimately transformed into transverse

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movements that drive dental instruments. However, the efficiency of magnetostrictive devices is relatively low, and continuous water cooling is required to prevent overheating.

Piezoelectric ultrasonic transducers, based on the inverse piezoelectric effect discovered by Jacques and Pierre Curie in 1880, are more commonly used. These devices convert high-frequency electrical current into mechanical oscillations by compressing and expanding piezoelectric crystals. Though piezoelectric instruments are susceptible to mechanical overload, which can damage the piezoelectric elements, advancements in nozzle design have expanded their clinical applications in areas such as implant maintenance, endodontic procedures, and minimally invasive surgical treatments.

In orthopedic dentistry, ultrasonic tools serve the following purposes:

Precise, minimally traumatic preparation of hard dental tissues.

Ultrasonic condensation of glass ionomer cements during crown and inlay placement.

Maintenance of fixed prostheses.

Simplified removal of crowns and bridges.

De-cementation of root pins for repeated endodontic treatment.

Physiotherapeutic applications.

Conducting axiography using ultrasonic devices.

Preparation of dental hard tissues is a critical step in fixed prosthodontics, as it involves the removal of a significant amount of tooth structure. This procedure impacts both the tooth's hard tissues and the pulp. Ultrasonic tips have been designed to enhance precision during crown preparation, particularly in areas where aesthetics are paramount. These tips are especially useful in patients with a thin periodontal biotype, as they help avoid soft tissue damage and subsequent bleeding.

Various manufacturers, including Acteon, EMS, Komet, and NSK, offer ultrasonic tips designed for different stages of dental tissue preparation. Most tips feature a diamond-coated working surface with varying degrees of abrasiveness tailored to specific operations. Professor Domenico Massironi, in collaboration with Komet, developed a set of scaler tips for the KaVo SONICflex system, including tools for subgingival preparation of fixed restorations. These instruments allow for efficient manipulation of the dental surfaces while preserving adjacent tissues.

In addition to standard diamond-coated nozzles, the EMS range includes a VE nozzle for final preparation under veneers. The shape and design of the working part allow for precise tooth surface preparation without harming adjacent teeth or soft tissues.

Satelec, in collaboration with dental experts, introduced its own line of ultrasonic tips for final tooth preparation. These tips enable easy adjustment of the preparation border beneath the gingival margin while ensuring optimal surface quality.

Ultrasonic tools offer several advantages during indirect restoration procedures, including improved soft tissue preservation and optimal surface texture for enhanced biological, functional, and aesthetic integration. The use of ultrasonic condensation tips further ensures superior marginal adaptation of restorations and better adhesion to dental tissues.

Ultrasonic technology also plays a vital role in implant maintenance and the treatment of peri-implantitis. Specialized tips made from materials like titanium ensure effective plaque removal without damaging the implant surface. Additionally, ultrasonic de-cementing tips simplify the

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removal of fixed crowns and bridges, enabling safe separation of the prosthesis from the underlying tooth structure.

In physiotherapy, low-frequency ultrasound is used for its analgesic, anti-inflammatory, and tissue-restructuring effects. Conditions such as temporomandibular joint disorders, fractures, and muscle contractures can be treated using ultrasound therapy, which promotes faster rehabilitation and healing.

Ultrasound-based diagnostic methods, such as ultrasonic axiography, have become integral in biofunctional prosthetics. These systems record the movement of the lower jaw in three-dimensional space, providing data for personalized treatment planning and facilitating the integration of indirect restorations.

In conclusion, ultrasonic technologies have greatly enhanced the precision and efficiency of orthopedic dental procedures. These advancements not only improve clinical outcomes but also contribute to the long-term durability, aesthetics, and functionality of dental restorations

Conclusions

The introduction of ultrasonic technologies in orthopedic dentistry has significantly enhanced the precision and efficiency of various clinical procedures. Ultrasonic instruments allow for minimally invasive preparation of dental tissues, offering advantages such as reduced trauma to both hard and soft tissues, precise manipulation of prosthetic materials, and improved long-term outcomes for fixed restorations. The development of specialized nozzles for different applications, such as veneer preparation, subgingival restoration, and implant maintenance, has expanded the versatility of ultrasonic devices in modern dental practices.

Ultrasound technology has simplified many complex procedures, such as the removal of fixed prostheses, de-cementation of root pins, and the condensation of cements during prosthetic placement. It has also improved soft tissue preservation, reduced the risk of injury, and enhanced the biological, functional, and aesthetic integration of indirect restorations. Additionally, ultrasonic physiotherapy offers therapeutic benefits for conditions such as temporomandibular joint disorders and dental system anomalies, contributing to quicker rehabilitation.

Ultrasonic diagnostics, such as axiography, provide valuable insights into jaw movements, supporting more accurate treatment planning and functional integration of restorations. Overall, the continued development and adoption of ultrasonic technologies will improve the quality of prosthetic treatments, enhance patient outcomes, and streamline dental workflows in orthopedic dentistry.

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