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"Microplastics in Endodontics and Restorative Dentistry: Emerging Concerns and Future Implications"

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ABSTRACT: The environmental impact of microplastics has garnered significant attention in recent years, particularly regarding their leaching from materials used in Endodontics. Microplastics, which include both primary and secondary types, are released from products such as retainers, dental materials,rubber dam,endo files and burs etc., These particles are defined as microplastics (MPs) if they are smaller than 5 mm, and nanoplastics if smaller than 1000 nm. MPs are typically synthetic polymer particles or fibers with diameters ranging from 1 to 5000 μm, though the European Food Safety Authority (EFSA) extends the definition to particles as small as 100 nm. The ingestion of microplastics has been associated with potential health risks, such as oxidative stress and inflammation. As a result, it is essential to deepen our understanding of microplastics to reduce their potential risks to both human health and the environment.

KEYWORDS: Endodontics nanoparticles, environmental hazard, microplastics

I. INTRODUCTION

In recent years, the presence of microplastics in the environment has raised increasing concerns about public health[1].Two major dental products contributing to microplastic pollution are toothpaste and composite restoration materials, with the growing field of Endodontics also playing a role[1].The persistence of plastics in the environment coupled with their ability to act as vectors for pollutants highlights the complexity and gravity of the issue [2]While it is well-established that plastic materials can degrade both mechanically and environmentally, releasing microplastics (MPs), thermoplastic materials still offer several benefits. Despite this, our understanding of this emerging contamination is still limited, especially regarding its sources, exposure routes, persistence, transport, and potential toxicity[1].For example, microplastics and nanoplastics can form when larger plastic items break down or fragment due to physical factors like scratching or cutting[5]. Microplastics, defined as plastic particles smaller than 5 mm, and nanoplastics, smaller than 1000 nm, are commonly found in everyday products[1].Therefore, advancing our knowledge of these materials is essential before we can implement effective strategies to reduce their potential risks

Burs

Rotating instruments used for shaping and cleaning the inside of a tooth, particularly during root canal treatment. These burs are typically made from materials such as stainless steel or tungsten carbide, and their function is to remove damaged or infected tissue, as well as to prepare the root canal for filling.[6]

Relationship between Endodontic Burs and Microplastics

Although microplastics are generally associated with environmental pollution (tiny plastic particles less than 5mm in size), they are becoming an area of concern in various medical fields, including dentistry:

Use of Plastics in Dental Instruments:

While endodontic burs themselves are not made of plastic, other components in the dental office, such as dental files, trays, or even some cleaning materials, may contain plastics or plastic composites.Over time, fragments from these tools could contribute to microplastic pollution, especially if they are disposed of improperly.[6]

Plastic Contamination from Dental **Procedures**:

The friction created by rotating burs during dental procedures could lead to the shedding of small plastic particles from other equipment (e.g., plastic tips, syringes, or dental molds). These plastic particles, if not adequately managed or disposed of, could eventually enter the environment as microplastics.

Microplastics in Dental Waste:

If plastic-based products or consumables (like dental liners, disposable cups, or cleaning agents) break down into microplastics, they can accumulate in waste streams, contributing to environmental pollution. Some studies suggest that microplastic particles can even enter the human body via ingestion or inhalation during procedures, though this remains an area of active research.[9]

While endodontic burs themselves are not typically a direct source of microplastic pollution, the broader context of dental practice—particularly in terms of plastic waste from disposable items or other dental tools—could contribute to the growing concern over microplastic contamination. Awareness and proper disposal of dental waste, along with a move toward more sustainable materials, can help mitigate these risks.

Rubber dams

The relationship between rubber dams and microplastics primarily revolves around the environmental impact of the materials used in rubber dams, which are often made from synthetic rubber or similar polymers[7]. Here's how they are linked:

Microplastic Release: Over time, rubber dams or their components may degrade due to factors like UV exposure, weathering, or mechanical wear. This degradation can lead to the release of tiny plastic particles, which can break down into microplastics.[7]

Source of Microplastics: As these rubber-based products wear out or are disposed of improperly, they can contribute to the growing issue of microplastics in the environment. While the primary concern with microplastics often relates to consumer products like plastic bottles, clothing, or packaging, synthetic materials like rubber used in dams, boats, or industrial applications can also contribute.[7]

Environmental Impact: Rubber dams, especially in aquatic environments, can indirectly increase the spread of microplastics. The materials can leach into waterways, eventually contributing to microplastic pollution, which harms marine life, contaminates ecosystems, and enters the food chain.

While rubber dams serve critical purposes in water management and flood control, their long-term environmental impacts, including potential microplastic pollution, are an area of concern that may drive future research and innovation in materials that are more sustainable and less prone to environmental degradation.[7]

Dental files

Traditional Files: Dental files, which are used for shaping and cleaning the root canal in endodontic procedures, have traditionally been made from metals such as stainless steel or nickel-titanium. These materials do not break down into microplastics[.8]

Plastic-coated or Composite Files: Some newer dental files, particularly those designed to be flexible or have enhanced durability, may have plastic or polymer coatings, or may even be made entirely from synthetic materials. These could potentially shed microplastic particles during use, especially if the plastic material degrades or is worn down by friction.[8]

2. Potential for Microplastic Generation:

Wear and Friction: During dental procedures, files are subjected to mechanical forces, such as rotational or lateral movements. If the file contains or is coated with plastic materials (e.g., polymers, resins), these could wear down and release microplastic particles into the environment or into the patient's oral cavity.[9]However, the release of microplastics from metal files is not a concern, as they do not degrade into small plastic particles.

Waste and Disposal: After dental procedures, discarded dental files (especially those with plastic coatings) could contribute to microplastic pollution if not properly disposed of. Like other single-use plastic products, improperly disposed dental files could break down into microplastics in landfills or in marine environments.

3. Environmental Impact:

Plastic Waste: If dental files, particularly disposable or plastic-coated files, are not properly recycled, they may end up in waste streams where they could break down into microplastics over time. This could contribute to the broader issue of microplastic pollution, which has become a significant environmental concern[9]

Biodegradation: Plastics used in dental materials, including dental files, do not typically biodegrade in a way that would eliminate their microplastic potential, which means that they could persist in the environment for extended periods.

4. Health Implications:

Release of Microplastics: While there is

little evidence currently to suggest that microplastics from dental files could pose a significant health risk during a procedure, there is some concern about the long-term effects of microplastic exposure, especially if particles were to enter the bloodstream or tissues[9]. However, these concerns are more pertinent to the overall issue of microplastics in general, not specifically to dental files.

The direct relationship between dental files and microplastics is primarily linked to the use of plastic or polymer-coated files, or disposable files made entirely from synthetic materials. The wear and tear on these materials during clinical procedures could, in theory, contribute to the generation of microplastics. However, the most significant environmental concern would come from improper disposal of plastic-coated or disposable files, which could eventually break down into microplastics if not handled responsibly. More research and attention are needed to address this potential environmental impact.[9]

II. CONCLUSION

In conclusion, while the direct effects of microplastics in endodontics are not yet fully understood, there are potential risks that warrant further investigation. Endodontic materials, such as composites and some types of dental files, may degrade over time and release microplastic particles into the oral cavity or the environment[1]. However, the risk of significant health impacts from microplastics released during endodontic procedures appears to be minimal based on current research, as these materials are designed to be biocompatible and stable.[1]

The primary concern is the environmental impact of dental waste, particularly the improper disposal of plastic-containing materials, which could contribute to the growing issue of microplastic pollution. Therefore, more attention should be given to improving the biodegradability of dental materials and ensuring proper waste management practices in the dental field.[6]

As research in this area continues, it will be important to monitor the long-term effects of microplastic exposure from dental materials and develop sustainable practices to minimize their environmental footprint[6]

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