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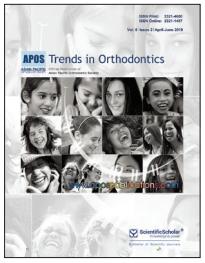

Editorial

The potential health hazards associated with clear aligners

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Orthodontic treatment has evolved significantly over the years, with a notable shift toward more esthetically pleasing options. Initially, this transformation began with the introduction of ceramic, transparent, and lingual braces, which aimed to provide effective fixed orthodontic solutions with less visible hardware.[1,2] Building on this trend, clear aligners (CA) have been introduced as a more discreet and comfortable alternative, offering patients the convenience of removable, nearly invisible aligners. These custom-made high-quality plastic devices facilitate the maintenance of daily routines while achieving proper tooth alignment.[3]

However, it is essential to address the potential hazards associated with plastic aligners. Research has revealed the presence of microplastics and nanoplastics (MNPs) in our environment and within our bodies.[4] This raises concerns regarding the possibility of leaching thermoplastic materials, including MNPs, from aligners and retainers over extended periods of wear. Orthodontic treatment often involves wearing these devices for 2 years or longer in the case of retainers.

Studies have shown the presence of these particles within atheromas in the arterial walls, which pose potential risks to cardiovascular health. The cardiovascular effects of MNPs include abnormalities in heart rate, pericardial edema, myocardial fibrosis, and vascular effects such as hemolysis, thrombosis, and blood coagulation. In addition, MNPs have been found to exacerbate the cardiovascular toxicity of other environmental contaminants, further affecting the heart and blood vessels.[5]

Another concern that needs to be addressed is the potential impact of microplastics on human gut health. Recent studies have provided evidence of the accumulation of microplastics in the digestive system, which raises serious concerns regarding their toxicity and long-term effects on the gut microbiota. Ingestion of these microplastics directly or indirectly through contaminated food and water sources poses significant risks to gut health and overall well-being. In the gut, MNPs can cause various forms of damage, including cellular deformation, enterocyte decomposition, inflammation, genotoxicity, and oxidative stress responses. It has been observed that nanoparticles lead to a decrease in digestive enzyme activity, induce goblet cell enlargement, and increase mucus secretion. In addition, they trigger the secretion of proinflammatory cytokines such as tumor necrosis factor α, interferon γ, and interleukin-6. This inflammatory response leads to leukocyte infiltration, hyperemia, and loss of villi and crypt cells. Furthermore,

these microplastics can enter the bloodstream, spread to other tissues, and persist within the body for prolonged periods.[6]

Furthermore, emerging evidence calls for an examination of the potential effects of MNPs on the reproductive system. Animal studies have revealed that exposure to plastic particles may disrupt reproductive organs and regulate hormone levels. MNPs can accumulate in the reproductive organs of mammals and elicit toxic effects on their reproductive systems, irrespective of their sex. In males, the detrimental effects of microplastics include abnormalities in testicular and sperm structure, decreased sperm vitality, and disruption of endocrine function. These effects are primarily attributed to oxidative stress, inflammation, testicular cell apoptosis, autophagy, abnormal cytoskeleton, and disturbances in the hypothalamic–pituitary–testicular axis. Similarly, in females, microplastics can cause abnormalities in the structure of the ovaries and uterus, as well as disrupt endocrine function. This damage is believed to be induced by oxidative stress, inflammation, apoptosis of granulosa cells, abnormalities in the hypothalamic–pituitary–ovarian axis, and tissue fibrosis.[7] It is important to conduct further investigations to determine any potential link between the use of plastic aligners and their adverse reproductive effects in humans, especially considering their popularity among adolescents and young adults.

In addition to its implications for human health, the environmental consequences associated with plastic aligners are significant.[8] The presence of MNPs in the atmosphere confirms their widespread occurrence in the environment. The easy airborne transmission of these particles raises serious concerns regarding human inhalation and the subsequent deposition in the respiratory system. Research has shown that microplastics can trigger inflammation, oxidative stress, and impaired lung function. Moreover, the small size of microplastics enables them to deeply infiltrate the lungs and reach the alveoli, which are the site of gas exchange. This raises concerns about long-term health effects, including the development of respiratory diseases and their potential translocation to other organs.[9]

An encouraging solution for mitigating the detrimental effects of plastic aligners is the development of effective recycling processes. Given the growing global concern regarding plastic waste, it is essential to explore environmentally friendly alternatives and promote responsible disposal of CAs. Manufacturers should prioritize the use of recyclable materials and educate patients about proper recycling methods, thereby preventing CA from contributing to the escalating problem of plastic pollution.[10]

With the growing popularity of these devices, it is essential for researchers, healthcare professionals, manufacturers, and patients to collaborate in comprehensive studies, responsible usage guidelines, and recycling practices. This collaboration is crucial to ensure the safety of users and the environment. By recognizing these concerns and promoting cooperation, we can strive for an effective, safe, and sustainable orthodontic treatment. Addressing plastic-related issues within the framework of one health system requires interdisciplinary collaboration, scientific innovation, and technological advancements. Strengthening communication and cooperation across different areas of expertise, as well as exploring new research methodologies and technologies, are vital steps in resolving plastic-related problems. In addition, orthodontists and dental professionals are responsible for prioritizing patient safety and ensuring that the materials used in orthodontic treatment are effective and safe for long-term use.[11]

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