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Editorial: Advanced use of materials in orthodontics

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Editorial on the Research Topic
Advanced use of materials in orthodontics

New technologies and new materials have a profound impact on Dentistry in general and in Orthodontics in particular, like the introduction of CAD/CAM techniques for digital appliance design and manufacturing and new 3D-printed materials. This was main thought behind the decision to have the Research Topic "*Advanced Use of Materials in Orthodontics*".

Among the recent innovations that changed many aspects of our specialty, CAD/CAM technologies are the most important: surely they have changed the way Orthodontics is nowadays provided, and will definitely play a key role in the future development of Orthodontics. In the Research Topic, Ludwig et al., studied the application of 3D-printed resin insertion guides for orthodontic miniscrew placement in an *in-vitro* environment. They found out that not all kinds of resin are suitable for the realization of surgical insertion guides, because the sterilization process can have a large impact on some materials' dimensional properties. On the other hand, an adequate resin can take advantage from the sterilization process, resulting in an improved insertion accuracy.

When thinking about CAD/CAM technologies in Orthodontics, probably clear aligners are the biggest players. This is reflected by the number of articles submitted to this Research Topic dealing on various aspects of clear aligners technology. Macrì et al. provided an interesting narrative review on different clinical and technological aspects of clear aligners. We believe this article is a great starting lecture for everyone willing to know more about aligners clinical performance, but also a stimulus for young researchers looking for project ideas. The use of attachments represented also an alluring topic for different research groups, and this is not surprising since attachments are a crucial medium introduced to improve the transfer of forces and moments from the aligner to the teeth, thus substantially contributing to clear aligners' clinical effectiveness. Gazzani et al. evaluated the type of composite resin used for the application of attachments, concluding that conventional nanocomposites are the materials best suited for the clinical needs.

Moreover, Ferlias et al. analyzed different shapes of attachments in an *in-vitro* setting to evaluate which geometry provided the highest derotational moment on an upper second premolar. This study could have a great clinical impact, since it highlights the importance in choosing the appropriate attachment geometry for various types of dental movement. Moreover, this study highlights that each attachment has some side-effects: for example, a vertical rectangular attachment seems to provide the greatest rotational moment, but at the cost of higher intrusion and inclination movement.

Elshazly et al. presented a highly innovative *in-vitro* study by evaluating the forces produced by 3D-printed aligners made of shape memory polymers, so-called "four dimensional aligners". Indeed, the possibility to directly 3D printing the aligners – avoiding the steps of printing the models, thermoforming and then refining the aligners – the possibility to have materials with a high shape memory, and the possibility to have different thickness of the walls within the same aligner represent an incredible advantage over conventional produced aligners. Studies like the one presented in this Research Topic show the future direction in the clinical use of aligners, which will probably become the "new-normal" in the near future.

Furthermore, biomaterials' innovation means the possibility to have materials that carry a biological effect. Crawford et al., presented the possible application of nanoparticles releasing nitric oxide for tooth movement modulation. Many researchers studied methods to influence tooth movement acting at a biochemical level, with alternating fortune. However, the use of locally injected nanoparticles with the ability to release active ingredients could be a promising technology. Crawford et al. obtained a significant result in Sprague-Dawley rats, inhibiting tooth movement for 1 week to achieve an "orthodontic anchorage effect"; nevertheless, further studies are needed to better understand the biological mechanism and to optimize nitric oxide treatment efficacy and longevity.

Even old materials like elastomers, which are extensively used in daily practice, may reveal new features and clinically useful information: Castroflorio et al. evaluated the forces produced by different types of Class II intermaxillary elastics, concluding that 3/16" 4.5 oz elastics are the most reliable ones in terms of declared force and overtime degradation.

The introduction of new biomaterials and of the digital workflow deeply changed the way Orthodontics is planned and practiced nowadays. The articles in this Research Topic demonstrated that this is the case and that their use will play an increasing role, havingan even larger impact for the future of the profession.

Author contributions

PC and MT drafted the manuscript, PC and DC revised the manuscript.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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