




Dental Restorations

Mauro Mandurino , Giovanna Laura Di Domenico , Sofia Baldani, Giacomo Collivasone, Enrico Felice Gherlone, Giuseppe Cantatore and Gaetano Paolone * 

Dental School, IRCCS San Raffaele Hospital, Vita-Salute University, 20132 Milan, Italy; giovannalauradd@gmail.com (G.L.D.D.); s.baldani@studenti.univr.it (S.B.); g.collivasone@gmail.com (G.C.); gherlone.enrico@hsr.it (E.F.G.); cantatore.giuseppe@hsr.it (G.C.)

* Correspondence: paolone.gaetano@hsr.it

1. Novelties in Restorative Dentistry and Endodontics

Fulfilling a patient's request for a healthy, functional and esthetic smile represents a daily challenge for dental practitioners. A rise in requests for esthetic dental treatments has led to the introduction of new materials, treatments and procedures able to provide non-invasive, long lasting and predictable treatment options [1–3]. The aim of this article is to present the latest innovations concerning the dental field reported by this journal.

This collection of articles related to restorative dentistry and endodontics [4–9], published in *Bioengineering*, includes novel restorative solutions for the most common problems that clinicians and patients can relate to: dental decay and dental fracture [10,11]. Regarding dental fracture, traumatic dental injuries (TDIs) concern mostly children and young adults [12]. In most cases, dental injuries involve anterior teeth, especially the maxillary upper incisors. Crown fractures, with or without pulp exposure, are the most common type of trauma in permanent dentition [13]. Radwanski et al. [4] aimed to present a possible conservative treatment for complicated tooth fracture in a case report. This technique consisted of partial pulpotomy followed by the adhesive reattachment of the tooth fragment using a pre-heated resin composite [4]. When a tooth fragment is available and viable for the clinicians to work on it, it should be reattached [14]. To achieve the best level of structural strength and aesthetic mimicry of the reattached fragment, clinicians should instruct patients (and usually the children's parents) on how to store, retrieve, and rehydrate the fragment. In this clinical case, after the application of MTA on one of the two upper incisors during a complicated pulpo-dentinal fracture, the fragment was reattached without any modifications sustained to the tooth or the fragment. In both teeth and fragments, the selective enamel etching was performed using a 36% phosphoric acid gel under rubber-dam isolation. Then, a self-etching two-component adhesive system was applied following the manufacturer's instructions, and air-dried with a strong stream of air for 5 s to completely remove the excess adhesive before light curing. Subsequently, a thin layer of enamel composite was applied directly on the tooth as an intermediate material to perform fragment reattachment. The composite was previously heated up to 54 °C to allow the better adaptation of the fragment to the tooth and to provide more manageable removal of the excess resin [15]. The adhesive reattachment of a fragment, combined with vital pulp-therapy procedures, represents the first-choice treatment option in cases of both simple and complicated crown fractures [4,16]. This technique may therefore help the clinician and allow a better outcome.

The other major problem that dentists deal with daily is the treatment of tooth decay. Dental caries has been classified as the most common oral disease, as it affects around 60–90% of adolescents and 100% of grownups around the world [17,18]. The progression of dental decay and the involvement of the pulp in the carious lesion lead firstly to clinical scenarios of pulpitis and then eventually to necrosis of the pulp. It is simple to understand how untreated or undiagnosed caries could lead to endodontic treatments, and if not carried out correctly, to the loss of the tooth. Clinicians and patients should therefore always agree



Citation: Mandurino, M.; Di Domenico, G.L.; Baldani, S.; Collivasone, G.; Gherlone, E.F.; Cantatore, G.; Paolone, G. Dental Restorations. *Bioengineering* **2023**, *10*, 820. <https://doi.org/10.3390/bioengineering10070820>

Received: 6 June 2023
Accepted: 4 July 2023
Published: 10 July 2023



Copyright: © 2023 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

on intervening as soon as possible when carious lesions are diagnosed. Moreover, the best material and technique should be prioritized in order to prevent secondary caries. Currently, dental restorations performed with adhesives and composites represent the state of the art. However, the inherent composition of dental adhesives and composites has a high affinity for dental plaque (biofilms) accumulation, leading to secondary caries [19–23]. Additionally, resin-based restorative materials are highly susceptible to degradation, which may compromise the duration of such restorations over time [24–32]. The deterioration of the restoration margin is strictly correlated with that of the hybrid layer [33]. The hybrid layer is the interface created by the application of the adhesive system; in this thin layer elution is one of the major causes of void creation. The presence of these voids enhances the proteolytic activity of endogenous matrix metalloproteinases (MMPs) which leads to secondary caries progression. As explained by Beck and Ilie [6], different studies were produced to develop simplified, clinically applicable and efficient protocols for the usage of photoactivated Riboflavin (RB) in the dentin bonding process. Riboflavin—probably better known as vitamin B2—is a compound that, thanks to its activity, could reinforce the collagen network by cross-linkage, making it more resistant to proteolytic attacks. Their *in vitro* study published in *Bioengineering* aimed to test a primer incorporated with RB 3% (wt/vol) [6]. Their results, on extracted human teeth, showed that even though some parameters might indicate less long-term degradation for RB test groups, the lower shear bond strength (SBS) values show that RB-photosensitized crosslinking cannot be transferred to clinical applications yet. On the other hand, researchers and industries are continuously developing RBCs and adhesive systems characterized by prolonged antibacterial agent release or contact-killing surfaces [34,35]. Antimicrobial nanoparticles may, for example, be of particular value [36]. The potential ability of nanoparticles to control oral biofilms is gaining popularity. Thus, their physicochemical characteristics, such as their degree of hydrophobicity, surface charge, and the surface-area-to-mass ratio of the plaque biofilm, are being investigated. Incorporating antibacterial compounds inside an RBC seems to reduce the risk of failure due to secondary caries. Moreover, nanoparticles may act in different ways: by causing cell lysis due to their interaction with the peptidoglycan cell wall and membrane; by altering protein synthesis; or by preventing DNA replication. Nevertheless, as reported by Balhaddad et al. [7], although the current data seem promising, long term results are lacking, resulting in an uncertainty on their reliability after aging. Moreover, potential cytotoxicity may be hypothesized and studies investigating it in the literature is scarce.

As previously mentioned, the lack of diagnosis and treatment of carious lesions leads to evolution of various presentations of pulp pathology which results in the endodontic treatment of the tooth. The purpose of root canal treatment (RCT) is to maintain the function of a tooth, cure disorders of the pulp, and prevent and treat diseases of periapical tissue. Although any RCT performed correctly, in compliance with the guidelines, can give excellent results over time, there is no doubt that the operator's experience can play a fundamental role in the success of the therapy itself. In the study carried out by Pietrzycka et al. [8] different groups of students (4th and 5th grade) and operators with different levels of experience were compared to understand if there were some differences in the quality of RCTs and in the number of visits needed to complete a primary RCT. To compare clinical results, the post-endo rx was analyzed according to several parameters, like the length and density of the RCT, and was linked with different filling criteria (adequate, overfilling, short filling or inadequate). The results showed that both the largest number of visits and the lowest quality of RCT was performed by students in the 4th grade. In contrast, endodontists needed the lowest number of visits to complete RCT and reached a higher quality of root canal filling compared to the other operator groups. Nevertheless, a major limitation of this study was that different groups used different types of instruments (manual or rotary) to complete the RCT [8]. After a successful endodontic treatment, which includes a proper access cavity, shaping, irrigation, and the tri-dimensional filling of the root canal space, clinicians need to select the most appropriate restoration for each endodontically

treated tooth (ETT) [37–40]. Very often, it is not easy to restore endodontically treated teeth, due to the lack of residual dental structure [32,41]. Over time we have moved from metallic-post-type restorations, which were cemented traditionally inside the canal, to restorations that are based on the placement of fiber-posts, which have the advantage of being cemented following adhesive procedures [42]. However, it has been demonstrated and debated in the literature that post-placement leads to the excessive removal of the dentin substance [43]. For this reason, industries are evolving towards the use of multi-fiber-reinforced composite (mFRC) based on a bundle of fibers that are bonded directly to the root canal. The application of mFRC into the root canal space does not require any use of post-space preparation [44]. Therefore, the adaptation of mFRC to the root canal anatomy, without additional dentin removal, may be of advantage for tissue preservation [45]. Kharouf et al. [5] investigated the bond strength to root canal dentin and the filling ability of a new multi-fiber-reinforced composite post (mFRC) compared to a conventional single-fiber-reinforced composite post (sFRC). In this in vitro study, extracted human premolars were firstly selected, scanned with a CBCT and instrumented by the same operator, then the sFRC and mFRC were placed into the canals after adhesive treatment was carried out. The adaptation and the presence of voids was analyzed by using scanning electron microscopy (SEM). Moreover, the adhesion of the two types of composites was studied via the push-out bond strength (PBS). The mFRC exhibited superior results in filling ability compared to sFRC. However, the bonding ability of the mFRC to dentin may have been lower at the coronal third compared to the sFRC [5].

Continuing in the field of endodontics, one of the challenges that has required the commitment of clinicians and researchers in recent decades is the controversial topic of regenerative endodontics. In necrotic teeth with immature roots, the possibility of restoring their full functionality is an attractive goal, since the regeneration of lost tissues improves the longevity of these elements. This topic is discussed in a review published in *Bioengineering* [9], which firstly explains the various differences between the state-of-the-art regenerative endodontic techniques and then introduces their new regenerative approach, in order to restore the homeostatic balance of the treated tooth. The use of multipotent-stem-cell (MSC)-derived secretome, such as CM or EV, instead of cell therapy, can promote the stimulation of proliferation and differentiation of MSC from dental pulp towards odontoblasts, blood vessels and nerves. This concept may represent the basis for a new regenerative endodontics strategy.

2. Novelties in Implantology

When tooth preservation is not possible, tooth extraction appears inevitable. Once a tooth is lost, rehabilitation may require the placement of an implant. The dimensional bone and soft-tissue alterations following tooth extraction have a significant impact on the esthetic outcome of implant-supported restorations [46]. Several preclinical and clinical studies showed that, during the first weeks following a tooth extraction, remodeling activity takes place, resulting in marked bone resorption, mainly at the level of the buccal wall [47–49].

Over recent decades, several surgical procedures, denominated “alveolar ridge preservation”, have been introduced, aiming to maintain the existing soft and hard tissues as well as a stable ridge volume, to simplify subsequent treatment procedures and to optimize functional and aesthetic outcomes [50]. Currently, a broad spectrum of grafting materials of different origins, such as allografts, xenografts, and alloplastic materials, are available [51,52]. A recent randomized controlled clinical trial evaluated the effect of a solid PRF on the soft-tissue healing of molar and premolar extraction sockets at 3 months follow-up [53]. When the test group (PRF-treated) was compared to a control one (non-PRF-treated), results demonstrated that PRF leads to a significantly faster ridge sealing and a lower contraction of the wound. Contrarily, no differences between the two groups in terms of patients’ pain perception were reported. However, when bone dehiscence is present at the time of implant placement, different bone regenerative techniques, such as

guided bone regeneration (GBR), need to be used to allow the correct placement of a dental implant. GBR is a successful, well-documented and widely used dental surgical procedure to treat various alveolar bone defects, using membranes and bone-grafting. It allows the surgical site to be colonized by bone-tissue cells surrounding the regeneration area and the re-establishment of local bone volume [54,55]. Moreover, it can be performed before or at the time of implant placement. Different protocols and a combination of biomaterials have been proposed for bone-regeneration procedures. A recent pre-clinical study was conducted in order to evaluate a new technology for producing a cell-seeded fibrin gel with the same shape and size of the bone defect to be treated [56]. The scaffold was composed of fibrin glue and dental-pulp stem cells (DPSC) coming from the periodontal ligament, that were layered onto the 3D-printed scaffold surface. The authors concluded that the combination of DPSCs and fibrin gel can be used to promote bone regeneration. Indeed, the fibrin glue is a sufficient material for scaffolds with good mechanical characteristics, while the DPSCs maintain their viability, immunophenotype and osteogenic potential. Funato et al. [57] described, in a retrospective case series, a minimally invasive novel resorbable membrane-pouch technique, performed in conjunction with implant placement, where collagen membranes were secured to the periosteum without the need of titanium pins. A total of 11 patients were included and treated with immediate ($n = 3$) or delayed implants ($n = 8$). The surgical procedure consisted of a full-thickness flap elevation, which was connected to a partial-thickness flap in the basal area of the maxilla, and of a prosthetically driven crestal-implant placement. Then, a resorbable membrane was trimmed to fit and was inserted beneath the periosteum and secured to it using resorbable sutures. Demineralized bovine bone mineral was positioned in the internal space of the pouch, surrounded by the resorbable membrane and exposed labial implant surface. Finally, to achieve good esthetic soft-tissue results, a connective-tissue graft (CTG) was also placed on the buccal superior aspect and secured to the periosteum or mucosal flap. Results showed that all implants were successful and functional, with optimal soft-tissue health and esthetics. A key element for the high aesthetic score seems to be the simultaneous CTGs performed. Indeed, in recent years, soft-tissue management with the use of connective tissue grafts around implants is of utmost importance to mimic natural ideal conditions, and for this reason it has become a topic of growing interest for clinicians. Several studies investigating the augmentation of buccal soft tissue with autogenous CTG in conjunction with an IIP have showed reliable results compensating for the volume changes of the facial tissues after implant placement [58,59]. Among these, a recent study indicated that the addition of a CTG at the time of an IIP seems to reduce the horizontal changes of the alveolar ridge that occur, and allows the maintenance of the tissue contour due to an increase in soft-tissue thickness [60].

Although implant therapy has undergone significant improvements, complications are still reported with a high frequency. There are two categories of complications that occur in implant therapy: biological and technical (mechanical) [61].

“Biological complications” refer to disturbances in the function of the implant, characterized by biological processes that affect the supporting tissues, including peri-implant diseases [62,63]. Etiological and risk factors for peri-implant diseases have been identified in several experimental and clinical studies performed in recent years [62,64,65]. Microbial plaque accumulation is considered to be the most important factor in the pathogenesis of peri-implant diseases, similarly to periodontitis, and the presence of micro-gaps at the implant–abutment interface has been implicated in several studies as the source of bacterial penetration [66]. This bacterial reservoir can negatively impact the health of the peri-implant tissue, leading to inflammation and bone loss. A recent in vitro study evaluated the microleakage of two bacterial species with different diameters (*S. oralis* and *P. aeruginosa*) at the implant–abutment interfaces of three different implant connections (external hexagon, internal hexagon, cone morse taper internal connection) [67]. Results indicated that although the components were assembled according to the manufacturer’s recommendations, microleakage of the selected microorganisms occurred. Typically, bone

resorption in peri-implantitis lesions affected the more coronal region of the implant and only gradually proceeded in the apical direction [68]. Occasionally, peri-implantitis may develop apically, in the same way that a dental periapical lesion does (without the coronal crest bone being involved). This type of lesion is indicated with the term “implant periapical lesion” and it represents a distinct pathological entity [69]. Luongo et al. [70] described two different approaches to treat this type of peri-implant periapical lesion: the removal of the implant (case n.1) or the removal of its apical portion (case n.2). According to the authors, the last treatment option appeared to be predictable, since it allowed elimination of the inflammatory tissue and the maintenance of the remaining part of the fixture, which became optimally osseointegrated.

“Technical complications” serve as a collective term for mechanical damage to the implant/implant components and supra-structures. One of the key elements impacting osseointegration is the stability of the connection between the fixture and the abutment. In particular, it may be difficult and complicated to achieve a passive fit when restoring several, non-parallel, and splinted implants. In these clinical situations, non-engaging abutments are one of the several types of abutment connections that are available and are frequently utilized in multi-unit cases where they need to have a passive fit and not exert too much stress on the implants [71]. However, limited evidence is available on the stress distribution of these type of abutments. For this reason, using finite element analysis, a recent study aimed to evaluate the biomechanical characteristics of a new EZ-post non-engaging abutment system of a BlueDiamond[®] implant (BD group; Megagen, Bedfordshire, UK), compared to a similar system of an AnyOne implant (AO group; Megagen, Bedfordshire, UK) [72]. On the basis of the obtained results, the authors concluded that the new EZ-post non-engaging abutment of the BD implant may be used in clinical settings in a manner similar to that of the AO abutment system. Indeed, results showed that the fixture and the stress distribution, at the level of surface where the fixture and the abutment make contact, were lower in the AO group than in the BD group. Nevertheless, at the same time, the AO group had a greater incidence of abutment fracture, compared to the BD group. In order to obtain properly osseointegrated implants, new surface treatments are being introduced as well as new handpieces. Aysesek et al. [73] investigated, in their study, the topographical, chemical and osseointegration characteristics of an implant surface treated with sandblasting and acid etching, compared to a new boron and boric-acid (H₃BO₃) treatment in sheep tibia. They concluded that boron treatment and coating produced a smoother surface compared to the conventional one. This property seemed to cause lesser resistance against reverse rotational forces in the short term (3 weeks). Nevertheless, in the long term (7 weeks), it provided significant resistance to rotational forces and no adverse reactions. Boric acid treatment seems to be promising and deserves further investigations to fully comprehend which is the best dose and method of application.

On the other hand, Park et al. [74] compared the osseointegration of dental implants placed using two dental laser-implant handpiece systems. Implants were placed in rabbit tibia using a conventional laser-implant handpiece and a multi-laser handpiece system under development. They found no statistically significant difference between the two groups. Therefore, considering the limitations of this study, the type of laser-implant handpiece did not seem to affect osseointegration and soft tissue healing. For many years, an alternative to dental implants has been sought, and recently Bektas et al. [75] described the characterization of tooth-germ organoids cultured with hydrogel microparticles. These have recently demonstrated their role in tissue repair and regeneration, facilitated by their characteristics. Furthermore, they possess a scaffold ability, the effective cell and drug delivery, and a property to mimic the extracellular matrix. This material served as an extensive surface area for human dental-pulp stem cells and porcine dental epithelial cells to attach and proliferate to. Interestingly, it self-assembled into organoids, within which the cells managed to maintain their viability and morphology during the incubation period. These organoids reached a volume of ~50 mm³ within two weeks of culture. Both the human-pulp stem cells and the porcine epithelial cells attached to each other without

any external intervention. These findings demonstrate the tooth-regeneration potential of tooth-bud organoid-like structures.

3. Novelty in Orthodontics

Orthodontics is a pivotal branch in dentistry, which allows tooth movement through different devices. Although fixed orthodontic treatments demonstrate notable advantages [76,77], one of their widely reported side effects is oral mucosa lesions due to the presence of sharp edges [78–80]. Traumatic oral ulceration (TOU) occurs during the first period of treatment and may cause pain during feeding or speaking, compromising patients' compliance [78]. TOUs disappear within 10–14 days after removing the origin cause [81]; meanwhile, it could be useful to self-medicate the injury [82] or apply orthodontic wax on the braces to relieve pain [83]. Among tested products that aim to prevent TOUs or to speed up healing [84,85], a new gel (BMG0722) (BMG Pharma S.p.a., Milan, Italy) has been evaluated in Tremolati's study [86]. It is composed of hyaluronic acid (HA) and polyvinylpyrrolidone (PVP): PVP creates a barrier that allows both a decrease in pain and faster healing [85], while HA reduces inflammation [87,88] and promotes the healing process, as it is also used in other dentistry treatments, for example, after scaling in chronic periodontitis [89,90]. In the literature, its effectiveness regarding TOU treatment has been proved [91]; furthermore, Tremolati et al. [86] analyzed the different results on the healing process of TOUs between the combination of orthodontic wax and BMG0722 gel, and the combination of orthodontic wax with a placebo gel, during orthodontic treatment. In this double-blind RCT, a VAS-scale test and lesion measurements at T0, T1, and T2 were examined: out of 110 subjects screened, only 57 patients terminated the follow-up period. Thus, this study confirmed that this new combination speeds up healing and reduces pain symptoms (VAS score at 5 days after TOU onset) compared to the orthodontic wax and placebo combination (VAS of 0.44 and 4.00, respectively), and also diminishes the dimension of a lesion after 5 days of treatment [86]. Thanks to its ability to reduce oral mucosa pain [92] and enamel lesions due its conventional bracket system [93], to enable the treatment of severe orthodontic disorders [94] and to allow better comfort, esthetics and hygiene, orthodontic treatment using clear aligners has gained popularity. Through the growth of producer companies [95], nowadays, over 10 million patients have tried out this new orthodontic technique [96]. Nevertheless, the main side effect is that, although general treatment time has decreased compared to conventional systems, in extraction cases it has increased.

Clear aligner treatment (CAT) has developed thanks to software planning, improved transparent thermoplastic materials and resin attachments [97,98]. Although they are often composed by cytotoxic materials, such as polymethyl methacrylate (PMMA), the curing process might decrease this potential risk, but not avoid it totally [95]. Indeed, incomplete conversion seems to increase the release of monomers, such as methyl methacrylate (MMA), triethylene glycol dimethacrylate (TEGDMA), 2-hydroxyethyl methacrylate (HEMA), and bisphenol A glycidyl methacrylate (Bis-GMA) [99], that could cause cytotoxicity, mutagenicity, teratogenicity and estrogenicity [100]. Thus, Francisco's systematic review aimed to analyze the release of toxic monomers from 3D resin devices and their systemic influences, and included in vivo and in vitro studies [101,102]. A total of 14 articles were evaluated, but the risk of bias was considered medium/high; hence, the results of the monomers released by resin are not reliable and the literature needs more studies with the same methods, aligner fabrication and resin components to reach more comparable results [103]. Meanwhile, the orthodontists must pay attention to apply the aligners only for short treatments, with patients at non-fertile ages, and instruct them to take care with it, especially through avoiding hot foods [101]. As previously mentioned, CAT could also treat complex malocclusions thanks to the forces exerted on teeth [104]. Multiple studies have followed the development of new techniques to measure orthodontic forces [99,105], but a universal device capable of precisely detecting the strength applied by orthodontic treatments has not yet been found. For this reason, Lee's study [96] shows an innovative orthodontic

force-measurement method which allows the monitoring of the deformation of a pliant semi-sphere sensor, composed of a biocompatible polymer bonded to the inner aligner surface or to the tooth surface. The sensor is economic, simple and states the symmetry and homogeneity of the forces on the attachment, calculating the exerted force and the resulting orthodontic movement over the tooth's surface. The change in the contact area in the semi-sphere sensor was measured by a microscope, while the changing force can be monitored by changes to the contact area between the sensor and the aligner's inner surface. Hence, the sensor could establish the force exerted on a specific sensor part: further improvements to this 3D sensor would be a group of numerous semi-sphere sensors in different positions for the directional investigation of the forces [96]. Furthermore, it could also be useful to analyze forces applied in more complex situations, such as in malformations or transversal deficits. Vale et al. [106] investigated mandibular hypoplasia treatment; this is the most common growth disorder of the facial skeleton in Western Europe, ranging from 41% to 56%. It could be related to congenital malformation syndromes, angle class II occlusions, convex profile, and mandibular deficiency [107]; the need of orthodontic-surgical treatment [108] to correct dental occlusion, masticatory and respiratory function in cases of class II skeletal malformations [109] must be evaluated in relation to their severity. Indeed, although the orthodontic-surgical-orthognathic technique is widely diffused [110], it has major risks and a long treatment time (it is divided into four stages: the presurgical orthodontic phase, the surgical phase (BSSO), the post-surgical stage and an optional surgical-intervention stage to eliminate the osteosynthesis plates) and it is only suggested for adult patients, since skeletal growth is finished. For previously mentioned reasons, other procedures, such as mandibular distraction osteogenesis (DO), for dentofacial-deformity treatment have been investigated [111]. In the literature, results were not homogeneous: several systematic reviews assessed that both BSSO and DO methods can lead to enhanced hard and soft tissue, but the DO technique has less risk of relapse after five years follow-up [112]. Since external distractors have several side effects (discomfort, psychosocial problems because of the distractor's perceptibility and dimension, instability in the anchorage, the risk of dental and/or nerve lesion, and the presence of edema or localized infections), intraoral distractors have mainly been used to treat transverse jaw deformities, causing less psychosocial disorders thanks to their diminished volume, lower infection rate without the need of surgery, lower morbidity and better stability in fixation [113]. Nevertheless, difficulties in managing the vector direction to avoid asymmetry or posterior mandible rotation persist [114]. Recently, a new intraoral individual distractor for the lower jaw, bonded in the first molar and lower canine, was tested by Vale's study: it included a stainless-steel disjunction screw that, through rotation-pressure, enables expansion up to 12 mm [106]. When applying this new device in a distraction osteogenesis technique, soft tissues better adapt to the gradual bone elongation compared to in the BSSO technique, decreasing the relapse rate arising from robust soft-tissue tensions [115]. Hence, distractors should be evaluated for the treatment of lower jaw hypoplasia and retrognathia, instead of conventional surgical treatment, for their improvements regarding the patient's toleration and their development of the anterior mandibular bone segment, without posterior mandibular rotation or an influence on the gonial angle or transverse angulation of the segments [106].

As previous mentioned, transversal deficit is another worldwide disorder usually associated with malocclusions, often those of the upper-jaw-present single or bilateral cross-bite [116]; predisposing factors are congenital alterations, dystrophies, metabolic disorders, infections, trauma, atypical swallowing or oral breathing [117]. Skeletal and dental expansion are the primary treatment for a skeletal or dentoalveolar transverse deficiency [118]. Expansion treatment lasts two or four months, in addition to a retention period (from 4 to 6 months), but it could be faster during childhood thanks to the fibrous texture of the median palatine suture [117]. Although several orthodontists solve this malocclusion with TADs (Temporary Anchorage Devices), many colleagues also achieve excellent results with rapid or slow expander: rapid palatal expander in deciduous or early mixed dentition, or slow expander (NPE-2 or similar) in permanent dentition. The

rapid palatal expander (RPE) performs fast expansion, activating considerable forces at the sutural site by using a key [119]. Through this fixed device, it was demonstrated that after two weeks, there is a rise in width due to skeletal growth of 80% and due to teeth's movement of 20%, while in patients treated with slow expander, like Nitanium® Palatal Expander™, the rise in width is 50% orthodontic and 50% orthopedic. Furthermore, rapid palatal expander (RPE) and Nitanium Palatal Expander-2 (NPE-2) were compared in Montaruli's [120] retrospective study to assess their upper-jaw expansion effectiveness on thirty-six subjects with a mild to severe transverse maxillary deficiency and unilateral or bilateral posterior cross-bite. After a digital analysis of 3D models, the measurements of the anterior arch width, the posterior arch width, the palate height, and palatal surface were investigated and all data collected in this study indicated that both devices were suitable for solving transverse deficiency, with the choice of the most suitable related to patients' age and the type of dentition [120].

Conflicts of Interest: The authors declare no conflict of interest.

References

- Barboza, A.C.S.; Dos Santos, P.H.; do Vale, L.R.; de Oliveira Gallinari, M.; Assmann, A.; Vidal, C.M.P.; Fagundes, T.C.; Briso, A.L.F. Dental Bleaching with Violet LED: Effects on Dentin Color Change, Resin-Dentin Bond Strength, Hybrid Layer Nanohardness and Dentinal Collagen Biostability. *Photodiagnosis Photodyn. Ther.* **2021**, *33*, 102141. [[CrossRef](#)] [[PubMed](#)]
- Paolone, G. Direct Composites in Anteriors: A Matter of Substrate. *Int. J. Esthet. Dent.* **2017**, *12*, 468–481.
- Paolone, G. Direct Composite Restorations in Anterior Teeth. Managing Symmetry in Central Incisors. *Int. J. Esthet. Dent.* **2014**, *9*, 12–25. [[PubMed](#)]
- Radwanski, M.; Caporossi, C.; Lukomska-Szymanska, M.; Luzi, A.; Sauro, S. Complicated Crown Fracture of Permanent Incisors: A Conservative Treatment Case Report and a Narrative Review. *Bioengineering* **2022**, *9*, 481. [[CrossRef](#)]
- Kharouf, N.; Sauro, S.; Jmal, H.; Eid, A.; Karrouf, M.; Bahlouli, N.; Haikel, Y.; Mancino, D. Does Multi-Fiber-Reinforced Composite-Post Influence the Filling Ability and the Bond Strength in Root Canal? *Bioengineering* **2021**, *8*, 195. [[CrossRef](#)]
- Beck, F.; Ilie, N. Riboflavin and Its Effect on Dentin Bond Strength: Considerations for Clinical Applicability—An In Vitro Study. *Bioengineering* **2022**, *9*, 34. [[CrossRef](#)] [[PubMed](#)]
- Balhaddad, A.A.; Garcia, I.M.; Mokeem, L.; Alsaifi, R.; Collares, F.M.; Sampaio de Melo, M.A. Metal Oxide Nanoparticles and Nanotubes: Ultrasmall Nanostructures to Engineer Antibacterial and Improved Dental Adhesives and Composites. *Bioengineering* **2021**, *8*, 146. [[CrossRef](#)]
- Pietrzycka, K.; Radwanski, M.; Hardan, L.; Bourgi, R.; Mancino, D.; Haikel, Y.; Lukomska-Szymanska, M. The Assessment of Quality of the Root Canal Filling and the Number of Visits Needed for Completing Primary Root Canal Treatment by Operators with Different Experience. *Bioengineering* **2022**, *9*, 468. [[CrossRef](#)]
- Costa, L.A.; Eiro, N.; Vaca, A.; Vizoso, F.J. Towards a New Concept of Regenerative Endodontics Based on Mesenchymal Stem Cell-Derived Secretomes Products. *Bioengineering* **2022**, *10*, 4. [[CrossRef](#)]
- Kazemina, M.; Abdi, A.; Shohaimi, S.; Jalali, R.; Vaisi-Raygani, A.; Salari, N.; Mohammadi, M. Dental Caries in Primary and Permanent Teeth in Children's Worldwide, 1995 to 2019: A Systematic Review and Meta-Analysis. *Head Face Med.* **2020**, *16*, 22. [[CrossRef](#)]
- Azami-Aghdash, S.; Azar, F.E.; Azar, F.P.; Rezapour, A.; Moradi-Joo, M.; Moosavi, A.; Oskouei, S.G. Prevalence, Etiology, and Types of Dental Trauma in Children and Adolescents: Systematic Review and Meta-Analysis. *Med. J. Islam. Repub. Iran.* **2015**, *29*, 234. [[PubMed](#)]
- Bourguignon, C.; Cohenca, N.; Lauridsen, E.; Flores, M.T.; O'Connell, A.C.; Day, P.F.; Tsilingaridis, G.; Abbott, P.V.; Fouad, A.F.; Hicks, L.; et al. International Association of Dental Traumatology Guidelines for the Management of Traumatic Dental Injuries: 1. Fractures and Luxations. *Dent. Traumatol.* **2020**, *36*, 314–330. [[CrossRef](#)] [[PubMed](#)]
- Majewski, M.; Kostrzewska, P.; Ziolkowska, S.; Kijek, N.; Malinowski, K. Traumatic Dental Injuries—Practical Management Guide. *Pol. Merkur. Lek.* **2022**, *50*, 216–218.
- Garcia, F.C.P.; Poubel, D.L.N.; Almeida, J.C.F.; Toledo, I.P.; Poi, W.R.; Guerra, E.N.S.; Rezende, L.V.M.L. Tooth Fragment Reattachment Techniques—A Systematic Review. *Dent. Traumatol.* **2018**, *34*, 135–143. [[CrossRef](#)] [[PubMed](#)]
- Lopes, L.C.P.; Terada, R.S.S.; Tsuzuki, F.M.; Giannini, M.; Hirata, R. Heating and Preheating of Dental Restorative Materials—A Systematic Review. *Clin. Oral. Investig.* **2020**, *24*, 4225–4235. [[CrossRef](#)]
- Comba, A.; Baldi, A.; Carossa, M.; Paolone, G.; Stura, I.; Migliaretti, G.; Scotti, N. A Three-Step Etch-and-Rinse vs a Universal Adhesive in Nanohybrid Composite Anterior Restorations: A Retrospective Clinical Evaluation. *J. Adhes. Dent.* **2023**, *25*, 87–97. [[CrossRef](#)]
- Edelstein, B.L. The Dental Caries Pandemic and Disparities Problem. *BMC Oral. Health* **2006**, *6* (Suppl. S1), S2. [[CrossRef](#)]
- Martins, M.T.; Sardenberg, F.; Bendo, C.B.; Abreu, M.H.; Vale, M.P.; Paiva, S.M.; Pordeus, I.A. Dental Caries Remains as the Main Oral Condition with the Greatest Impact on Children's Quality of Life. *PLoS ONE* **2017**, *12*, e0185365. [[CrossRef](#)]

19. Balhaddad, A.A.; Kansara, A.A.; Hidan, D.; Weir, M.D.; Xu, H.H.K.; Melo, M.A.S. Toward Dental Caries: Exploring Nanoparticle-Based Platforms and Calcium Phosphate Compounds for Dental Restorative Materials. *Bioact. Mater.* **2019**, *4*, 43–55. [[CrossRef](#)]
20. Ferrini, F.; Paolone, G.; Di Domenico, G.L.; Pagani, N.; Gherlone, E.F. SEM Evaluation of the Marginal Accuracy of Zirconia, Lithium Disilicate, and Composite Single Crowns Created by CAD/CAM Method: Comparative Analysis of Different Materials. *Materials* **2023**, *16*, 2413. [[CrossRef](#)]
21. Paolone, G.; Scolavino, S.; Gherlone, E.; Spagnuolo, G.; Cantatore, G. The “Pre-Finishing” Approach in Direct Anterior Restorations. A Case Series. *Dent. J.* **2021**, *9*, 79. [[CrossRef](#)] [[PubMed](#)]
22. Paolone, G.; Moratti, E.; Goracci, C.; Gherlone, E.; Vichi, A. Effect of Finishing Systems on Surface Roughness and Gloss of Full-Body Bulk-Fill Resin Composites. *Materials* **2020**, *13*, 5657. [[CrossRef](#)] [[PubMed](#)]
23. Marigo, L.; Nocca, G.; Fiorenzano, G.; Callà, C.; Castagnola, R.; Cordaro, M.; Paolone, G.; Sauro, S. Influences of Different Air-Inhibition Coatings on Monomer Release, Microhardness, and Color Stability of Two Composite Materials. *BioMed Res. Int.* **2019**, *2019*, 4240264. [[CrossRef](#)] [[PubMed](#)]
24. Balhaddad, A.A.; Garcia, I.M.; Mokeem, L.; Ibrahim, M.S.; Collares, F.M.; Weir, M.D.; Xu, H.H.K.; Melo, M.a.S. Bifunctional Composites for Biofilms Modulation on Cervical Restorations. *J. Dent. Res.* **2021**, *100*, 1063–1071. [[CrossRef](#)] [[PubMed](#)]
25. Vichi, A.; Balestra, D.; Scotti, N.; Louca, C.; Paolone, G. Translucency of CAD/CAM and 3D Printable Composite Materials for Permanent Dental Restorations. *Polymers* **2023**, *15*, 1443. [[CrossRef](#)]
26. Paolone, G.; Mazzitelli, C.; Boggio, F.; Breschi, L.; Vichi, A.; Gherlone, E.; Cantatore, G. Effect of Different Artificial Staining Procedures on the Color Stability and Translucency of a Nano-Hybrid Resin-Based Composite. *Materials* **2023**, *16*, 2336. [[CrossRef](#)]
27. Paolone, G.; Pavan, F.; Mandurino, M.; Baldani, S.; Guglielmi, P.C.; Scotti, N.; Cantatore, G.; Vichi, A. Color Stability of Resin-Based Composites Exposed to Smoke. A Systematic Review. *J. Esthet. Restor. Dent.* **2023**, *35*, 309–321. [[CrossRef](#)]
28. Paolone, G.; Mandurino, M.; De Palma, F.; Mazzitelli, C.; Scotti, N.; Breschi, L.; Gherlone, E.; Cantatore, G.; Vichi, A. Color Stability of Polymer-Based Composite CAD/CAM Blocks: A Systematic Review. *Polymers* **2023**, *15*, 464. [[CrossRef](#)]
29. Paolone, G.; Mandurino, M.; Scotti, N.; Cantatore, G.; Blatz, M.B. Color Stability of Bulk-Fill Compared to Conventional Resin-Based Composites: A Scoping Review. *J. Esthet. Restor. Dent.* **2023**, *35*, 657–676. [[CrossRef](#)]
30. Mazzitelli, C.; Paolone, G.; Sabbagh, J.; Scotti, N.; Vichi, A. Color Stability of Resin Cements after Water Aging. *Polymers* **2023**, *15*, 655. [[CrossRef](#)]
31. Paolone, G.; Mazzitelli, C.; Zechini, G.; Scolavino, S.; Goracci, C.; Scotti, N.; Cantatore, G.; Gherlone, E.; Vichi, A. Influence of Modeling Liquids and Universal Adhesives Used as Lubricants on Color Stability and Translucency of Resin-Based Composites. *Coatings* **2023**, *13*, 143. [[CrossRef](#)]
32. Paolone, G.; Mazzitelli, C.; Josic, U.; Scotti, N.; Gherlone, E.; Cantatore, G.; Breschi, L. Modeling Liquids and Resin-Based Dental Composite Materials—A Scoping Review. *Materials* **2022**, *15*, 3759. [[CrossRef](#)] [[PubMed](#)]
33. Baldi, A.; Comba, A.; Tempesta, R.M.; Carossa, M.; Pereira, G.K.R.; Valandro, L.F.; Paolone, G.; Vichi, A.; Goracci, C.; Scotti, N. External Marginal Gap Variation and Residual Fracture Resistance of Composite and Lithium-Silicate CAD/CAM Overlays after Cyclic Fatigue over Endodontically-Treated Molars. *Polymers* **2021**, *13*, 3002. [[CrossRef](#)] [[PubMed](#)]
34. Burke, F.M.; Ray, N.J.; McConnell, R.J. Fluoride-Containing Restorative Materials. *Int. Dent. J.* **2006**, *56*, 33–43. [[CrossRef](#)] [[PubMed](#)]
35. Ebi, N.; Imazato, S.; Noiri, Y.; Ebisu, S. Inhibitory Effects of Resin Composite Containing Bactericide-Immobilized Filler on Plaque Accumulation. *Dent. Mater.* **2001**, *17*, 485–491. [[CrossRef](#)] [[PubMed](#)]
36. Allaker, R.P. The Use of Nanoparticles to Control Oral Biofilm Formation. *J. Dent. Res.* **2010**, *89*, 1175–1186. [[CrossRef](#)]
37. Vichi, A.; Zhao, Z.; Paolone, G.; Scotti, N.; Mutahar, M.; Goracci, C.; Louca, C. Factory Crystallized Silicates for Monolithic Metal-Free Restorations: A Flexural Strength and Translucency Comparison Test. *Materials* **2022**, *15*, 7834. [[CrossRef](#)] [[PubMed](#)]
38. Baldi, A.; Comba, A.; Ferrero, G.; Italia, E.; Michelotto Tempesta, R.; Paolone, G.; Mazzoni, A.; Breschi, L.; Scotti, N. External Gap Progression after Cyclic Fatigue of Adhesive Overlays and Crowns Made with High Translucency Zirconia or Lithium Silicate. *J. Esthet. Restor. Dent.* **2022**, *34*, 557–564. [[CrossRef](#)] [[PubMed](#)]
39. Paolone, G.; Pavan, F.; Guglielmi, P.C.; Scotti, N.; Cantatore, G.; Vichi, A. In Vitro Procedures for Color Stability Evaluation of Dental Resin-Based Composites Exposed to Smoke: A Scoping Review. *Dent. Mater. J.* **2022**, *41*, 791–799. [[CrossRef](#)] [[PubMed](#)]
40. Gherlone, E.; Mandelli, F.; Cappare, P.; Pantaleo, G.; Traini, T.; Ferrini, F. A 3 Years Retrospective Study of Survival for Zirconia-Based Single Crowns Fabricated from Intraoral Digital Impressions. *J. Dent.* **2014**, *42*, 1151–1155. [[CrossRef](#)]
41. Comba, A.; Baldi, A.; Carossa, M.; Michelotto Tempesta, R.; Garino, E.; Llubani, X.; Rozzi, D.; Mikonis, J.; Paolone, G.; Scotti, N. Post-Fatigue Fracture Resistance of Lithium Disilicate and Polymer-Infiltrated Ceramic Network Indirect Restorations over Endodontically-Treated Molars with Different Preparation Designs: An In-Vitro Study. *Polymers* **2022**, *14*, 5084. [[CrossRef](#)] [[PubMed](#)]
42. Conserva, E.; Consolo, U.; Sancho, A.G.; Foschi, F.; Paolone, G.; Giovarrussio, M.; Sauro, S. Stress Distribution in Carbon-Post Applied with Different Composite Core Materials: A Three-Dimensional Finite Element Analysis. *J. Adhes. Sci. Technol.* **2017**, *31*, 2435–2444. [[CrossRef](#)]
43. Mangold, J.T.; Kern, M. Influence of Glass-Fiber Posts on the Fracture Resistance and Failure Pattern of Endodontically Treated Premolars with Varying Substance Loss: An in Vitro Study. *J. Prosthet. Dent.* **2011**, *105*, 387–393. [[CrossRef](#)] [[PubMed](#)]
44. Richert, R.; Robinson, P.; Viguie, G.; Farges, J.-C.; Ducret, M. Multi-Fiber-Reinforced Composites for the Coronaradicular Reconstruction of Premolar Teeth: A Finite Element Analysis. *Biomed. Res. Int.* **2018**, *2018*, 4302607. [[CrossRef](#)] [[PubMed](#)]

45. Capriotti, L.; Greco, K.; Paolone, G.; Sberna, M.T.; Cantatore, G. Removal of Fiber Posts during Endodontic Retreatments Using Ultrasonic Tips: A Comparison between Two Different Endodontic Fiber Posts. *G. Ital. Endod.* **2018**, *32*, 47–50. [[CrossRef](#)]
46. Chappuis, V.; Araújo, M.G.; Buser, D. Clinical Relevance of Dimensional Bone and Soft Tissue Alterations Post-Extraction in Esthetic Sites. *Periodontol. 2000* **2017**, *73*, 73–83. [[CrossRef](#)]
47. Araújo, M.G.; Lindhe, J. Dimensional Ridge Alterations Following Tooth Extraction. An Experimental Study in the Dog. *J. Clin. Periodontol.* **2005**, *32*, 212–218. [[CrossRef](#)]
48. Vignoletti, F.; de Sanctis, M.; Berglundh, T.; Abrahamsson, I.; Sanz, M. Early Healing of Implants Placed into Fresh Extraction Sockets: An Experimental Study in the Beagle Dog. II: Ridge Alterations. *J. Clin. Periodontol.* **2009**, *36*, 688–697. [[CrossRef](#)]
49. Discepoli, N.; Vignoletti, F.; Laino, L.; de Sanctis, M.; Muñoz, F.; Sanz, M. Early Healing of the Alveolar Process after Tooth Extraction: An Experimental Study in the Beagle Dog. *J. Clin. Periodontol.* **2013**, *40*, 638–644. [[CrossRef](#)]
50. Hämmerle, C.H.F.; Araújo, M.G.; Simion, M. Osteology Consensus Group 2011 Evidence-Based Knowledge on the Biology and Treatment of Extraction Sockets. *Clin. Oral Implants Res.* **2012**, *23* (Suppl. S5), 80–82. [[CrossRef](#)]
51. Wickramasinghe, M.L.; Dias, G.J.; Premadasa, K.M.G.P. A Novel Classification of Bone Graft Materials. *J. Biomed. Mater. Res. B Appl. Biomater.* **2022**, *110*, 1724–1749. [[CrossRef](#)] [[PubMed](#)]
52. Kao, S.T.; Scott, D.D. A Review of Bone Substitutes. *Oral. Maxillofac. Surg. Clin. N. Am.* **2007**, *19*, 513–521, vi. [[CrossRef](#)] [[PubMed](#)]
53. Ghanaati, S.; Śmieszek-Wilczewska, J.; Al-Maawi, S.; Neff, P.; Zadeh, H.H.; Sader, R.; Heselich, A.; Rutkowski, J.L. Solid PRF Serves as Basis for Guided Open Wound Healing of the Ridge after Tooth Extraction by Accelerating the Wound Healing Time Course—A Prospective Parallel Arm Randomized Controlled Single Blind Trial. *Bioengineering* **2022**, *9*, 661. [[CrossRef](#)] [[PubMed](#)]
54. Benic, G.I.; Hämmerle, C.H.F. Horizontal Bone Augmentation by Means of Guided Bone Regeneration. *Periodontol. 2000* **2014**, *66*, 13–40. [[CrossRef](#)]
55. Retzeppi, M.; Donos, N. Guided Bone Regeneration: Biological Principle and Therapeutic Applications. *Clin. Oral. Implant. Res.* **2010**, *21*, 567–576. [[CrossRef](#)]
56. Erukashvily, N.I.; Dombrovskaya, J.A.; Kotova, A.V.; Semenova, N.; Karabak, I.; Banashkov, R.E.; Baram, D.; Paderina, T.; Bilyk, S.S.; Grimm, W.-D.; et al. Fibrin Glue Implants Seeded with Dental Pulp and Periodontal Ligament Stem Cells for the Repair of Periodontal Bone Defects: A Preclinical Study. *Bioengineering* **2021**, *8*, 75. [[CrossRef](#)]
57. Funato, A.; Ishikura, C.; Naito, K.; Hasuike, A. Resorbable Membrane Pouch Technique for Single-Implant Placement in the Esthetic Zone: A Preliminary Technical Case Report. *Bioengineering* **2022**, *9*, 649. [[CrossRef](#)]
58. Zuiderveld, E.G.; van Nimwegen, W.G.; Meijer, H.J.A.; Jung, R.E.; Mühlmann, S.; Vissink, A.; Raghoobar, G.M. Effect of Connective Tissue Grafting on Buccal Bone Changes Based on Cone Beam Computed Tomography Scans in the Esthetic Zone of Single Immediate Implants: A 1-Year Randomized Controlled Trial. *J. Periodontol.* **2021**, *92*, 553–561. [[CrossRef](#)]
59. Kolerman, R.; Nissan, J.; Rahmanov, A.; Zenziper, E.; Slutzkey, S.; Tal, H. Radiological and Biological Assessment of Immediately Restored Anterior Maxillary Implants Combined with GBR and Free Connective Tissue Graft. *Clin. Implant. Dent. Relat. Res.* **2016**, *18*, 1142–1152. [[CrossRef](#)]
60. Guglielmi, D.; Di Domenico, G.L.; Aroca, S.; Vignoletti, F.; Ciaravino, V.; Donghia, R.; de Sanctis, M. Soft and Hard Tissue Changes after Immediate Implant Placement with or without a Sub-Epithelial Connective Tissue Graft: Results from a 6-Month Pilot Randomized Controlled Clinical Trial. *J. Clin. Periodontol.* **2022**, *49*, 999–1011. [[CrossRef](#)]
61. Berglundh, T.; Persson, L.; Klinge, B. A Systematic Review of the Incidence of Biological and Technical Complications in Implant Dentistry Reported in Prospective Longitudinal Studies of at Least 5 Years. *J. Clin. Periodontol.* **2002**, *29* (Suppl. S3), 197–212; discussion 232–233. [[CrossRef](#)]
62. Berglundh, T.; Armitage, G.; Araújo, M.G.; Avila-Ortiz, G.; Blanco, J.; Camargo, P.M.; Chen, S.; Cochran, D.; Derks, J.; Figuero, E.; et al. Peri-Implant Diseases and Conditions: Consensus Report of Workgroup 4 of the 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions. *J. Clin. Periodontol.* **2018**, *45* (Suppl. S20), S286–S291. [[CrossRef](#)] [[PubMed](#)]
63. Barone, A.; Covani, U.; Cornelini, R.; Gherlone, E. Radiographic Bone Density around Immediately Loaded Oral Implants. *Clin. Oral. Implants Res.* **2003**, *14*, 610–615. [[CrossRef](#)]
64. Derks, J.; Schaller, D.; Håkansson, J.; Wennström, J.L.; Tomasi, C.; Berglundh, T. Effectiveness of Implant Therapy Analyzed in a Swedish Population: Prevalence of Peri-Implantitis. *J. Dent. Res.* **2016**, *95*, 43–49. [[CrossRef](#)]
65. Vignoletti, F.; Di Domenico, G.L.; Di Martino, M.; Montero, E.; de Sanctis, M. Prevalence and Risk Indicators of Peri-Implantitis in a Sample of University-Based Dental Patients in Italy: A Cross-Sectional Study. *J. Clin. Periodontol.* **2019**, *46*, 597–605. [[CrossRef](#)] [[PubMed](#)]
66. Heitz-Mayfield, L.J.A.; Lang, N.P. Comparative Biology of Chronic and Aggressive Periodontitis vs. Peri-Implantitis. *Periodontol. 2000* **2010**, *53*, 167–181. [[CrossRef](#)]
67. D’Ercole, S.; Dotta, T.C.; Farani, M.R.; Etemadi, N.; Iezzi, G.; Comuzzi, L.; Piattelli, A.; Petrini, M. Bacterial Microleakage at the Implant-Abutment Interface: An In Vitro Study. *Bioengineering* **2022**, *9*, 277. [[CrossRef](#)] [[PubMed](#)]
68. Meffert, R.M. Periodontitis and Periimplantitis: One and the Same? *Pract. Periodontics Aesthetic Dent.* **1993**, *5*, 79–80+82.
69. McAllister, B.S.; Masters, D.; Meffert, R.M. Treatment of Implants Demonstrating Periapical Radiolucencies. *Pract. Periodontics Aesthet. Dent.* **1992**, *4*, 37–41.

70. Luongo, R.; Faustini, F.; Vantaggiato, A.; Bianco, G.; Traini, T.; Scarano, A.; Pedullà, E.; Bugea, C. Implant Periapical Lesion: Clinical and Histological Analysis of Two Case Reports Carried Out with Two Different Approaches. *Bioengineering* **2022**, *9*, 145. [[CrossRef](#)]
71. Dogus, S.M.; Kurtz, K.S.; Watanabe, I.; Griggs, J.A. Effect of Engaging Abutment Position in Implant-Borne, Screw-Retained Three-Unit Fixed Cantilevered Prostheses. *J. Prosthodont.* **2011**, *20*, 348–354. [[CrossRef](#)]
72. Byun, S.-H.; Seo, J.-H.; Cho, R.-Y.; Yi, S.-M.; Kim, L.-K.; Han, H.-S.; On, S.-W.; Kim, W.-H.; An, H.-W.; Yang, B.-E. Finite Element Analysis of a New Non-Engaging Abutment System for Three-Unit Implant-Supported Fixed Dental Prostheses. *Bioengineering* **2022**, *9*, 483. [[CrossRef](#)]
73. Ayşeşek, N.; Arisan, V.; Balcioglu, N.B.; Erol, A.; Kuruoğlu, F.; Tekkeşin, M.S.; Ersanlı, S. Boron- and Boric Acid-Treated Titanium Implant Surfaces in Sheep Tibia: A Histologic, Histomorphometric and Mechanical Study. *Bioengineering* **2022**, *9*, 705. [[CrossRef](#)]
74. Park, J.-H.; Son, K.; Son, Y.-T.; Kim, Y.-G.; Suh, J.-Y.; Lee, K.-B.; Lee, J.-M. Comparison of Osseointegration of Dental Implants Placed in Rabbit Tibia Using Two Dental Laser and Implant Handpiece Systems. *Bioengineering* **2022**, *9*, 681. [[CrossRef](#)] [[PubMed](#)]
75. Kilic Bektas, C.; Zhang, W.; Mao, Y.; Wu, X.; Kohn, J.; Yelick, P.C. Self-Assembled Hydrogel Microparticle-Based Tooth-Germ Organoids. *Bioengineering* **2022**, *9*, 215. [[CrossRef](#)] [[PubMed](#)]
76. Kaitsas, R.; Kaitsas, F.; Paolone, G.; Paolone, M.G. Ortho-Perio Risk Assessment and Timing Flowchart for Lingual Orthodontics in an Interdisciplinary Adult Ortho-Perio Patient: A Case Report of “Perio-Guided” Orthodontic Treatment. *Int. Orthod.* **2022**, *20*, 100598. [[CrossRef](#)]
77. Paolone, M.G.; Kaitsas, R.; Paolone, G.; Kaitsas, V. Lingual Orthodontics and Forced Eruption: A Means for Osseous and Tissue Regeneration. *Prog. Orthod.* **2008**, *9*, 46–57.
78. Kvam, E.; Bondevik, O.; Gjerdet, N.R. Traumatic Ulcers and Pain in Adults during Orthodontic Treatment. *Community Dent. Oral Epidemiol.* **1989**, *17*, 154–157. [[CrossRef](#)]
79. Paolone, G.; Mandurino, M.; Baldani, S.; Paolone, M.G.; Goracci, C.; Scolavino, S.; Gherlone, E.; Cantatore, G.; Gastaldi, G. Quantitative Volumetric Enamel Loss after Orthodontic Debracketing/Debonding and Clean-Up Procedures: A Systematic Review. *Appl. Sci.* **2023**, *13*, 5369. [[CrossRef](#)]
80. Lucchese, A.; Manuelli, M.; Bassani, L.; Albertini, P.; Matarese, G.; Perillo, L.; Gastaldi, G.; Gherlone, E.F. Fiber Reinforced Composites Orthodontic Retainers. *Minerva Stomatol.* **2015**, *64*, 323–333.
81. Baricevic, M.; Mravak-Stipetic, M.; Majstorovic, M.; Baranovic, M.; Baricevic, D.; Loncar, B. Oral Mucosal Lesions during Orthodontic Treatment. *Int. J. Paediatr. Dent.* **2011**, *21*, 96–102. [[CrossRef](#)] [[PubMed](#)]
82. Shaw, W.C.; Addy, M.; Griffiths, S.; Price, C. Chlorhexidine and Traumatic Ulcers in Orthodontic Patients. *Eur. J. Orthod.* **1984**, *6*, 137–140. [[CrossRef](#)] [[PubMed](#)]
83. Kluemper, G.T.; Hiser, D.G.; Rayens, M.K.; Jay, M.J. Efficacy of a Wax Containing Benzocaine in the Relief of Oral Mucosal Pain Caused by Orthodontic Appliances. *Am. J. Orthod. Dentofac. Orthop.* **2002**, *122*, 359–365. [[CrossRef](#)] [[PubMed](#)]
84. Rennick, L.A.; Campbell, P.M.; Naidu, A.; Taylor, R.W.; Buschang, P.H. Effectiveness of a Novel Topical Powder on the Treatment of Traumatic Oral Ulcers in Orthodontic Patients: A Randomized Controlled Trial. *Angle Orthod.* **2016**, *86*, 351–357. [[CrossRef](#)]
85. Leiva-Cala, C.; Lorenzo-Pouso, A.I.; Centenera-Centenera, B.; López-Palafox, J.; Gándara-Vila, P.; García-García, A.; Pérez-Sayáns, M. Clinical Efficacy of an Aloe Vera Gel versus a 0.12% Chlorhexidine Gel in Preventing Traumatic Ulcers in Patients with Fixed Orthodontic Appliances: A Double-Blind Randomized Clinical Trial. *Odontology* **2020**, *108*, 470–478. [[CrossRef](#)]
86. Tremolati, M.; Farronato, M.; Ferrantini, L.; Rusconi, F.; Lodi, G.; Maspero, C. Clinical Performance Evaluation of a Hyaluronic Acid Dental Gel for the Treatment of Traumatic Ulcers in Patients with Fixed Orthodontic Appliances: A Randomized Controlled Trial. *Bioengineering* **2022**, *9*, 761. [[CrossRef](#)] [[PubMed](#)]
87. Xu, Y.; Höfling, K.; Fimmers, R.; Frentzen, M.; Jervøe-Storm, P.M. Clinical and Microbiological Effects of Topical Subgingival Application of Hyaluronic Acid Gel Adjunctive to Scaling and Root Planing in the Treatment of Chronic Periodontitis. *J. Periodontol.* **2004**, *75*, 1114–1118. [[CrossRef](#)] [[PubMed](#)]
88. Farronato, M.; Maspero, C.; Abate, A.; Grippaud, C.; Connelly, S.T.; Tartaglia, G.M. 3D Cephalometry on Reduced FOV CBCT: Skeletal Class Assessment through AF-BF on Frankfurt Plane-Validity and Reliability through Comparison with 2D Measurements. *Eur. Radiol.* **2020**, *30*, 6295–6302. [[CrossRef](#)]
89. Ferrillo, M.; Nucci, L.; Giudice, A.; Calafiore, D.; Marotta, N.; Minervini, G.; d’Apuzzo, F.; Ammendolia, A.; Perillo, L.; de Sire, A. Efficacy of Conservative Approaches on Pain Relief in Patients with Temporomandibular Joint Disorders: A Systematic Review with Network Meta-Analysis. *Cranio* **2022**, 1–17. [[CrossRef](#)]
90. Canciani, E.; Sirello, R.; Pellegrini, G.; Henin, D.; Perrotta, M.; Toma, M.; Khomchyna, N.; Dellavia, C. Effects of Vitamin and Amino Acid-Enriched Hyaluronic Acid Gel on the Healing of Oral Mucosa: In Vivo and In Vitro Study. *Medicina* **2021**, *57*, 285. [[CrossRef](#)]
91. Casale, M.; Moffa, A.; Vella, P.; Rinaldi, V.; Lopez, M.A.; Grimaldi, V.; Salvinelli, F. Systematic Review: The Efficacy of Topical Hyaluronic Acid on Oral Ulcers. *J. Biol. Regul. Homeost. Agents* **2017**, *31*, 63–69.
92. Cardoso, P.C.; Espinosa, D.G.; Mecenas, P.; Flores-Mir, C.; Normando, D. Pain Level between Clear Aligners and Fixed Appliances: A Systematic Review. *Prog. Orthod.* **2020**, *21*, 3. [[CrossRef](#)]
93. Maspero, C.; Tartaglia, G.M. 3D Printing of Clear Orthodontic Aligners: Where We Are and Where We Are Going. *Materials* **2020**, *13*, 5204. [[CrossRef](#)] [[PubMed](#)]

94. Kassam, S.K.; Stoops, F.R. Are Clear Aligners as Effective as Conventional Fixed Appliances? *Evid. Based Dent.* **2020**, *21*, 30–31. [[CrossRef](#)] [[PubMed](#)]
95. Weir, T. Clear Aligners in Orthodontic Treatment. *Aust. Dent. J.* **2017**, *62* (Suppl. S1), 58–62. [[CrossRef](#)]
96. Lee, S.; Lee, C.; Bosio, J.A.; Melo, M.A.S. Smart Flexible 3D Sensor for Monitoring Orthodontics Forces: Prototype Design and Proof of Principle Experiment. *Bioengineering* **2022**, *9*, 570. [[CrossRef](#)]
97. Weinstein, T.; Marano, G.; Aulakh, R. Five-to-Five Clear Aligner Therapy: Predictable Orthodontic Movement for General Dentist to Achieve Minimally Invasive Dentistry. *BMC Oral. Health* **2021**, *21*, 671. [[CrossRef](#)]
98. Yassir, Y.A.; Nabbat, S.A.; McIntyre, G.T.; Bearn, D.R. Clinical Effectiveness of Clear Aligner Treatment Compared to Fixed Appliance Treatment: An Overview of Systematic Reviews. *Clin. Oral. Investig.* **2022**, *26*, 2353–2370. [[CrossRef](#)] [[PubMed](#)]
99. Saeed, F.; Muhammad, N.; Khan, A.S.; Sharif, F.; Rahim, A.; Ahmad, P.; Irfan, M. Prosthodontics Dental Materials: From Conventional to Unconventional. *Mater. Sci. Eng. C Mater. Biol. Appl.* **2020**, *106*, 110167. [[CrossRef](#)] [[PubMed](#)]
100. Shin, J.-W.; Kim, J.-E.; Choi, Y.-J.; Shin, S.-H.; Nam, N.-E.; Shim, J.-S.; Lee, K.-W. Evaluation of the Color Stability of 3D-Printed Crown and Bridge Materials against Various Sources of Discoloration: An In Vitro Study. *Materials* **2020**, *13*, 5359. [[CrossRef](#)]
101. Francisco, I.; Paula, A.B.; Ribeiro, M.; Marques, F.; Travassos, R.; Nunes, C.; Pereira, F.; Marto, C.M.; Carrilho, E.; Vale, F. The Biological Effects of 3D Resins Used in Orthodontics: A Systematic Review. *Bioengineering* **2022**, *9*, 15. [[CrossRef](#)]
102. Rogers, H.B.; Zhou, L.T.; Kusuhara, A.; Zanicke, E.; Shafaie, S.; Owen, B.C.; Duncan, F.E.; Woodruff, T.K. Dental Resins Used in 3D Printing Technologies Release Ovo-Toxic Leachates. *Chemosphere* **2021**, *270*, 129003. [[CrossRef](#)] [[PubMed](#)]
103. Iliadi, A.; Koletsi, D.; Papageorgiou, S.N.; Eliades, T. Safety Considerations for Thermoplastic-Type Appliances Used as Orthodontic Aligners or Retainers. A Systematic Review and Meta-Analysis of Clinical and In-Vitro Research. *Materials* **2020**, *13*, 1843. [[CrossRef](#)]
104. Robertson, L.; Kaur, H.; Fagundes, N.C.F.; Romanyk, D.; Major, P.; Flores Mir, C. Effectiveness of Clear Aligner Therapy for Orthodontic Treatment: A Systematic Review. *Orthod. Craniofacial Res.* **2020**, *23*, 133–142. [[CrossRef](#)] [[PubMed](#)]
105. Zheng, M.; Liu, R.; Ni, Z.; Yu, Z. Efficiency, Effectiveness and Treatment Stability of Clear Aligners: A Systematic Review and Meta-Analysis. *Orthod. Craniofacial Res.* **2017**, *20*, 127–133. [[CrossRef](#)] [[PubMed](#)]
106. Vale, F.; Queiroga, J.; Pereira, F.; Ribeiro, M.; Marques, F.; Travassos, R.; Nunes, C.; Paula, A.B.; Francisco, I. A New Orthodontic-Surgical Approach to Mandibular Retrognathia. *Bioengineering* **2021**, *8*, 180. [[CrossRef](#)] [[PubMed](#)]
107. Al-Moraissi, E.A.; Ellis, E. Bilateral Sagittal Split Ramus Osteotomy Versus Distraction Osteogenesis for Advancement of the Retrognathic Mandible. *J. Oral. Maxillofac. Surg.* **2015**, *73*, 1564–1574. [[CrossRef](#)] [[PubMed](#)]
108. Proffit, W.R.; Jackson, T.H.; Turvey, T.A. Changes in the Pattern of Patients Receiving Surgical-Orthodontic Treatment. *Am. J. Orthod. Dentofac. Orthop.* **2013**, *143*, 793–798. [[CrossRef](#)] [[PubMed](#)]
109. Experimental Healing of Distraction Osteogenesis Comparing Metaphyseal with Diaphyseal Sites—PubMed. Available online: <https://pubmed.ncbi.nlm.nih.gov/8156684/> (accessed on 29 May 2023).
110. Lucchese, A.; Gherlone, E.; Portelli, M.; Bertossi, D. Tooth Orthodontic Movement after Maxillofacial Surgery. *Eur. J. Inflamm.* **2012**, *10*, 227–232. [[CrossRef](#)]
111. Walker, D.A. Management of Severe Mandibular Retrognathia in the Adult Patient Using Distraction Osteogenesis. *J. Oral. Maxillofac. Surg.* **2002**, *60*, 1341–1346. [[CrossRef](#)]
112. Cohen, S.R.; Rutrick, R.E.; Burstein, F.D. Distraction Osteogenesis of the Human Craniofacial Skeleton: Initial Experience with New Distraction System. *J. Craniofacial Surg.* **1995**, *6*, 368–374. [[CrossRef](#)]
113. Guerrero, C.A.; Bell, W.H.; Contasti, G.I.; Rodriguez, A.M. Mandibular Widening by Intraoral Distraction Osteogenesis. *Br. J. Oral. Maxillofac. Surg.* **1997**, *35*, 383–392. [[CrossRef](#)]
114. McCarthy, J.G.; Williams, J.K.; Grayson, B.H.; Crombie, J.S. Controlled Multiplanar Distraction of the Mandible: Device Development and Clinical Application. *J. Craniofacial Surg.* **1998**, *9*, 322–329. [[CrossRef](#)]
115. McCarthy, J.G.; La Trenta, G.S.; Breitbart, A.S.; Grayson, B.H.; Bookstein, F.L. The Le Fort III Advancement Osteotomy in the Child under 7 Years of Age. *Plast. Reconstr. Surg.* **1990**, *86*, 633–646; discussion 647–649. [[CrossRef](#)] [[PubMed](#)]
116. Howe, R.P.; McNamara, J.A.; O'Connor, K.A. An Examination of Dental Crowding and Its Relationship to Tooth Size and Arch Dimension. *Am. J. Orthod.* **1983**, *83*, 363–373. [[CrossRef](#)]
117. Baccetti, T.; Franchi, L.; Cameron, C.G.; McNamara, J.A. Treatment Timing for Rapid Maxillary Expansion. *Angle Orthod.* **2001**, *71*, 343–350. [[CrossRef](#)] [[PubMed](#)]
118. Ballanti, F.; Lione, R.; Baccetti, T.; Franchi, L.; Cozza, P. Treatment and Posttreatment Skeletal Effects of Rapid Maxillary Expansion Investigated with Low-Dose Computed Tomography in Growing Subjects. *Am. J. Orthod. Dentofac. Orthop.* **2010**, *138*, 311–317. [[CrossRef](#)] [[PubMed](#)]
119. Wertz, R.A. Skeletal and Dental Changes Accompanying Rapid Midpalatal Suture Opening. *Am. J. Orthod.* **1970**, *58*, 41–66. [[CrossRef](#)]
120. Montaruli, G.; Virgilio, S.; Laurenziello, M.; Tepedino, M.; Ciavarella, D. Maxillary Transverse Deficit: A Retrospective Study of Two Biologically Oriented Devices through a Digital Workflow. *Bioengineering* **2022**, *9*, 31. [[CrossRef](#)]

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.