prosthesis

Review

CAD/CAM Abutments versus Stock Abutments: An Update Review

Simone Gallo [1], Maurizio Pascadopoli [1], Matteo Pellegrini [2,*], Federica Pulicari [3], Mattia Manfredini [4,*], Paolo Zampetti [2,*], Francesco Spadari [3], Carlo Maiorana [4] and Andrea Scribante [1]

1 Unit of Orthodontics and Pediatric Dentistry, Section of Dentistry, Department of Clinical, Surgical, Diagnostic and Pediatric Sciences, University of Pavia, 27100 Pavia, Italy
2 Section of Dentistry, Department of Clinical, Surgical, Diagnostic and Pediatric Sciences, University of Pavia, 27100 Pavia, Italy
3 Maxillo-Facial and Odontostomatology Unit, Department of Biomedical Surgical and Dental Sciences, Fondazione IRCCS Ca' Granda Ospedale Maggiore Policlinico, University of Milan, 20122 Milan, Italy
4 Maxillofacial Surgery and Odontostomatology Unit, Implant Center for Edentulism and Jawbone Atrophies, Fondazione IRCCS Cà Granda Ospedale Maggiore Policlinico, University of Milan, 20122 Milan, Italy
* Correspondence: matteo.pellegrini02@universitadipavia.it (M.P.); mattia.manfredini@unimi.it (M.M.); paolo.zampetti@unipv.it (P.Z.)

Abstract: With the evolution of CAD/CAM technology, custom titanium and/or zirconia abutments are increasingly being used, leading to several comparisons in the literature, both mechanical and aesthetic, to evaluate performance differences between these two types of abutments. Therefore, the aim of this comprehensive review is to present the most recent data on the latest comparisons between CAD/CAM and stock abutment applications. The PICO model was used to perform this review, through a literature search of the PubMed (MEDLINE) and Scopus electronic databases. CAD/CAM abutments allow individualization of abutment parameters with respect to soft tissue, allow increased fracture toughness, predict the failure mode, show no change in the fracture toughness over time, reduce the prosthetic steps, and reduce the functional implant prosthesis score and pain perceived by patients in the early stages. The advantages associated with the use of stock abutments mainly concern the risk of corrosion, time spent, cost, and fit, evaluated in vitro, in the implant–abutment connection. Equal conditions are present regarding the mechanical characteristics during dynamic cycles, screw loss, radiographic fit, and degree of micromotion. Further randomized controlled clinical trials should be conducted to evaluate the advantages reported to date, following in vitro studies about titanium and/or zirconia stock abutments.

Keywords: abutment–soft tissue interface; biomaterials; CAD/CAM abutments; dentistry; implant–abutment connection; implantology; prosthodontics; stock abutments; titanium; zirconia

check for updates

Citation: Gallo, S.; Pascadopoli, M.; Pellegrini, M.; Pulicari, F.; Manfredini, M.; Zampetti, P.; Spadari, F.; Maiorana, C.; Scribante, A. CAD/CAM Abutments versus Stock Abutments: An Update Review. *Prosthesis* **2022**, *4*, 468–479. https://doi.org/10.3390/prosthesis4030038

Academic Editor: Bruno Chrcanovic

Received: 18 July 2022
Accepted: 15 August 2022
Published: 16 August 2022

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

1. Introduction

Osseointegration and long implant longevity were the initial challenges of implant-supported prosthetic oral rehabilitation, which have been widely addressed in the literature to date [1].

Over time, given the increased expectations of patients, achieving a satisfactory aesthetic result has become progressively important, and this can also be achieved through high-quality prosthetic structures and customised morphology [2]. Additionally, it is necessary to establish the correct relationship between peri-implant mucosa, alveolar bone, and prosthetic materials [3]. Finally, peri-implant soft tissue also provides a protective barrier between the oral cavity and the underlying bone [4].

Mechanical loading, radiotherapy, prosthetic interference, and microbial biofilm negatively affect the transition zone between the mucosa and the abutment, compromising implant longevity [5,6].

Biofilm represents the primary etiological factor in the development of peri-implant mucositis and peri-implantitis [7], whose prevalence can reach 80% and 56%, respectively [8]. In this regard, recent studies highlighted that the peri-implant microbiota shows less bacterial differentiation than the periodontal microbiota, becoming more complex when moving from peri-implant mucositis to peri-implantitis [9,10]. Scaling and root planning represents the gold standard of nonsurgical treatment for peri-implant pathology, with some shortcomings, among which bacterial recolonization is the most represented [11]. As a result, additional therapeutic approaches have been proposed, including antibiotics [12], ozone application [13], photodynamic treatment [14,15], and probiotics [16], which have no side effects, and their anti-inflammatory effects toward peri-implant disease have been examined in a few studies [17,18].

Previous studies have defined how the material (titanium, precious alloys, alumina, and zirconia) and morphology of the abutment appear to be critical in ensuring proper epithelial-connective attachment between the mucosa and the abutment, stabilizing the mucosal margin and ensuring proper interproximal filling [19,20].

In addition, the functionality of implant-supported restorations and the health and stability of the peri-implant soft tissues is influenced by several other factors, such as the design and stability of the implant–abutment connection and the chemical composition and surface properties of the abutment constituent material [21].

Surface topography, surface free energy, and especially surface roughness are important factors in biofilm formation [22]. The optimal abutment surface should be smooth enough to prevent biofilm formation but rough enough (0.2 microns) to allow fibroblast adhesion [23].

Before the introduction of CAD/CAM technology (Computer-Aided Design/Computer-Aided Manufacturing), two main types of abutments were available: stock abutments, provided by dental implant manufacturers, and custom cast abutments [24].

Recently, implant abutments have also been produced by CAD/CAM technology; they can be adapted to individual and local situations, offering different advantages. Moreover, different materials can be used to realize abutments with CAD/CAM technology [25].

The respective advantages related to the use of CAD/CAM and stock abutments led to comparisons in the literature, both mechanical and aesthetic, aimed to assess differences in the performances between these two types of abutments.

Therefore, the aim of this review is to present the most recent data regarding the latest comparisons between the applications of CAD/CAM and stock abutments.

2. Materials and Methods

2.1. Focused Questions

Are there differences in the clinical performances between CAD/CAM abutments and stock abutments? What are the advantages in the application of the two types of abutments? Are there any equal conditions of use?

2.2. Eligibility Criteria

The following inclusion criteria guided the analysis of the studies:

Type of studies. Clinical trials, case–control studies, cross-sectional studies, cohort studies, narrative reviews, and systematic reviews.

Type of participants. Patients with titanium and/or zirconia CAD/CAM abutments and stock titanium and/or zirconia abutments for implant rehabilitations and in vitro models in which the mechanical properties of the two types of abutments were tested.

Type of interventions. Comparison of the clinical, mechanical, and esthetic performances of titanium and/or zirconia CAD/CAM abutments and titanium and/or zirconia stock abutments, assessed through case–control, cross-sectional, cohort, clinical, and review studies.

Outcome type. Identification of the advantages and equal conditions of using titanium and/or zirconia CAD/CAM abutments and titanium and/or zirconia stock abutments, both in vitro and for clinical use.

Only studies that met all the inclusion criteria were included. However, the following exclusion criteria were considered: (I) articles published in non-English languages, (II) studies where non-titanium or zirconia abutments were tested, (III) the presence of concomitant systemic diseases/treatments that could influence the results, (IV) animal clinical studies, and (V) the absence of ethics committee approval.

2.3. Search Strategy

The PICO model (Population, Intervention, Comparison, and Outcome) was used to perform this review through a literature search of the PubMed (MEDLINE) and Scopus electronic databases. Abstracts of studies that compared the mechanical and aesthetic characteristics, in vitro and in clinical use, of titanium and/or zirconia CAD/CAM abutments and titanium and/or zirconia stock abutments were reviewed.

2.4. Research

The search was performed using the following keywords: “biomaterials” AND “CAD/CAM abutments”, “implant-abutment connection” AND “implantology”, AND “abutment-soft tissue interface”, “prosthodontics” AND “stock abutments”, and “titanium” AND “zirconia”.

3. Results

CAD/CAM abutments allow the individualization of abutment parameters in implant rehabilitation with respect to soft tissue, reducing the risk of cement remaining in the peri-implant sulcus, improving the tissue support and papillary recession index [26–48]. Moreover, they allow for increased fracture toughness (two-piece CAD/CAM zirconia), and predict the failure mode (if containing titanium inserts). In clinical use, they show no change in the fracture toughness over time, and finally, CAD/CAM technology used in the construction of healing abutments makes it possible to reduce the prosthetic steps and reduce the functional implant prosthodontics score and pain perceived by patients in the early stages.

The advantages associated with the use of stock abutments relate primarily to the risk of corrosion, time spent, cost, and fit, assessed in vitro, in the implant–abutment connection.

Equal conditions are present regarding the mechanical characteristics at the dynamic cycles, screw loss, radiographic fit, and degree of micromotion [26–48].

Risk of Bias

The risk of bias of the main articles reviewed is shown in Table 1. This review has a moderate risk of bias.

The results of the search reveal that, with the MeSH terms “dental abutments” AND “dentistry”, there were 11,440 articles; with “dental abutments” AND “dental implants”, there were 13,778 publications; and with “dental abutments” AND “computer-aided design” AND “computer-aided manufacturing” 1219 articles, with “dental abutments” AND “dental esthetics” 2177 articles, and with “dental abutments” AND “mechanical tests”, there were 821 publications.

Regarding the MeSH terms “dental abutments” AND “dentistry”, the percentage of original articles is >85% and reviews are >7%, while the remaining studies are book chapters, conference papers, letters, erratum, short surveys, and editorials (<4%). For the MeSH terms “dental abutments” AND “mechanical tests”, the main publications are original articles (>95%). Less cited are conferences, reviews, and editorials (<4%). For the remaining MeSH terms, original articles are >90%; reviews are between 5 and 8%; and the residual productions consist of conferences, books, notes, letters, editorials, and short surveys (2 to 3%).

Table 1. Risk of bias of the studies is represented by the green symbol for a low risk of bias and a yellow symbol for a moderate risk of bias.

	Adequate Sequence Generated	Allocation Concealment	Blinding	Incomplete Outcome Data	Registration Outcome Data
Edelhoff Daniel et al. 2019 [26]	–	–	–	✓	✓
Valsan Monica Ioana et al. 2021 [27]	–	–	–	✓	✓
Mostafavi Azam Sadat et al. 2021 [28]	–	–	–	✓	✓
Schepke Ulf et al. 2017 [29]	–	✓	–	✓	✓
Schepke Ulf et al. 2019 [30]	✓	✓	✓	✓	✓
Chang Yu-Tsen et al. 2022 [31]	–	–	–	✓	✓
Gehrke Peter et al. 2015 [32]	✓	–	–	✓	✓
Fonseca Manrique et al. 2021 [33]	–	–	–	✓	✓
Alsahhaf Abdulaziz et al. 2017 [34]	–	–	–	✓	✓
Lops Diego et al. 2017 [35]	–	–	–	✓	✓
Cantieri Mello Caroline et al. 2019 [36]	–	–	–	✓	✓
Lops Diego et al. 2015 [37]	–	–	–	✓	✓
Beretta Mario et al. 2019 [38]	–	✓	✓	✓	✓
Haugen Håvard et al. 2022 [39]	–	–	–	✓	✓
Coray Rafaela et al. 2016 [40]	–	–	–	✓	✓
Paek Janghyun et al. 2016 [41]	–	–	–	✓	✓

Table 1. *Cont.*

	Adequate Sequence Generated	Allocation Concealment	Blinding	Incomplete Outcome Data	Registration Outcome Data
Lops Diego et al. 2018 [42]	✓	−	−	✓	✓
Alonso-Pérez Raquel et al. 2017 [43]	−	−	−	✓	✓
Apicella Davide et al. 2010 [44]	−	✓	✓	✓	✓
Jarman Joseph et al. 2017 [45]	−	−	−	✓	✓
Yilmaz Burak et al. 2015 [46]	−	−	−	✓	✓
Wittneben Julia-Gabriela et al. 2020 [47]	−	✓	✓	✓	✓
Karl Matthias et al. 2014 [48]	−	−	−	✓	✓

Figure 1 shows the trend of publications over the years regarding CAD/CAM and stock abutment population studies. Using the keywords "dentistry" AND "abutments", the first study present in PubMed (MEDLINE) dates back to 1945 [49]; however, in Scopus, until 1955 [50], there were no studies; with the keywords "CAD/CAM" AND "abutments", the first study present in PubMed (MEDLINE) dates back to 1976 [51], while, in Scopus, the first study dates back to 1989 [52].

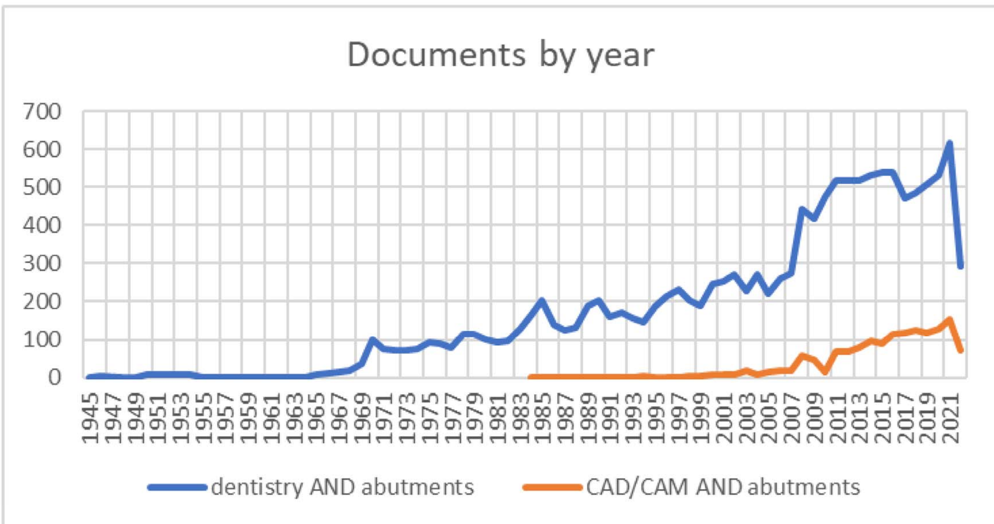

Figure 1. Number of research papers published up to 2022.

Until the 1980s, before the introduction of CAD/CAM, only standard abutments were on the market. Since the early 2000s, CAD/CAM has become increasingly used in clinical dental practice, leading to the introduction of the first CAD/CAM abutments. However, this resulted in the introduction of the term "stock" to differentiate standard versus digitally individualized abutments. From 2007 to 2011, an increase was seen with the keywords "dentistry" AND "abutments" from 275 articles to 518, while, for "CAD/CAM" AND "abutments", the trend changed from 17 to 68 publications; from 2011 to 2021, the trends for both keywords increased from 518 articles to 616 and from 68 to 155, respectively, for "dentistry" AND "abutments" and "CAD/CAM" AND "abutments". Up to the beginning of the year 2022, there have been 291 and 73 articles about the keywords "dentistry" and "CAD/CAM", respectively. The increased number of studies regarding the use of CAD/CAM highlight the great clinical interest in this well-established method, making dentistry increasingly individualized and digital.

4. Discussion

Through CAD/CAM technology, it is possible to optimize the geometry of the abutment, particularly the position of the finish line according to the roots of the contiguous tooth elements and the gingival margin, thus reducing the possibility of leaving cement remnants in the peri-implant sulcus [26,53].

CAD/CAM abutments have an excellent finishing line, thus avoiding sharp edges. They also compensate for poor implant angulation and provide a biological advantage, as they support and interact with the soft tissues, unlike stock abutments, in which it is the crown that performs this function [27]. On the other hand, stock abutments have several advantages: the industrial manufacturing process standardizes the quality of the product and ensures the use of biocompatible materials in the abutment–soft tissue interface [28]. Finally, there is less risk of corrosion due to the possible use of different alloys in the milled parts, and it is less time-consuming and expensive [29].

A recent study by Schepke et al. [30] showed that there is no significant difference in fracture toughness for the CAD/CAM zirconia abutments compared to their pristine copies after 1 year of clinical service, unlike the stock zirconia abutments, which showed a significant reduction in fracture toughness, although the maximum fracture toughness values still exceeded human chewing forces, which can exceed 250 N. However, for the zirconia abutments, it was possible to get a good fit and stability only with a conical connection and in the anterior zone, whereas, in the posterior area and in the internal hexagon connection, the use of zirconia abutments is not recommended [54].

In addition, abutments containing titanium inserts had higher fracture resistance than the full zirconia abutment. Titanium inserts affect the fracture patterns of the zirconia abutments. In case of a fracture, the presence of a titanium reinforcement leads to a higher possibility of a horizontal fracture surface. Without titanium inserts otherwise, an oblique fracture is more likely. Moreover, the titanium insert keeps the buccal fracture surface of the zirconia abutment away from the implant platform, thus protecting the implant–abutment connection [31].

Previous in vitro studies evaluated the static load fracture resistance of one-piece CAD/CAM zirconia abutments compared with stock zirconia abutments, showing that one-piece CAD/CAM zirconia abutments have lower static fracture loads than their stock counterparts [45,46].

Furthermore, dynamic loading can improve the fracture resistance of zirconia abutments, and two-piece CAD/CAM zirconia abutments are an equivalent alternative to titanium abutments in a single-implant restoration in the anterior region [47]. One-piece CAD/CAM zirconia abutments provided less favorable mechanical properties in fracture loads than two-piece CAD/CAM zirconia abutments and titanium abutments. The weakest point of one-piece CAD/CAM zirconia abutments was the area around the screwhead under dynamic loading and the internal connection under static loading [34].

Likewise, the studies by Schepke et al. [29] and Gehrke et al. [32] showed that two-piece CAD/CAM zirconia abutments with an internal hexagonal connection demonstrated a greater fracture resistance than single-piece CAD/CAM zirconia and stock zirconia abutments. Based on these results, two-piece abutments could be clinically advantageous in high-load areas, such as single premolar and molar tooth replacements.

However, the prospective cohort study by Fonseca et al. [33], with a follow-up of 4.5–8.8 years, showed how screw-retained implant crowns based on CAD/CAM zirconia abutments with a conical connection exhibited excellent clinical performance, recommending them for the replacement of missing anterior teeth and premolars.

Furthermore, assessing the implant–abutment interface after the dynamic loading of conventional titanium abutments compared to CAD/CAM zirconia abutments, the microgap values at the implant–abutment interface are equivalent to each other, demonstrating how CAD/CAM zirconia abutments can withstand functional forces, as well as stock titanium abutments [40].

Regarding peri-implant soft tissues, Lops et al. [35] showed that, for restorations supported by stock abutments, the mean papillary recession index (REC) was higher than for CAD/CAM abutments, both for titanium and zirconia abutments, in which slight papilla regrowth was also measured after 2 years of follow-up.

CAD/CAM abutments combine most of the advantages of stock and cast abutments since, in addition to a predictable fit and durability, all prosthetic parameters are modifiable, including the emergence file, thickness, finish line position, and outer contour [36]. For these reasons, a CAD/CAM abutment could improve the papilla support and avoid excessive papilla compression [37]. In addition, a clinical study showed how CAD/CAM technology used in the development of healing abutments requires fewer steps for prosthetic finalization than the standard healing abutments customized step by step with composite. Additionally, CAD/CAM healing abutments allow for a higher functional implant prosthodontics score, commonly used to evaluate both the functional and aesthetic results, and the perceived pain is less in the early stages of prosthetic rehabilitation [38].

Abutment material does not determine any significant difference in the degree of papillary recession for either stock abutments or CAD/CAM abutments made of titanium and zirconia, given the biocompatibility of these materials [39].

It has been shown that, after the application of 5000 cycles of cyclic loading, with a force between 10 N and 250 N, there is no significant difference in screw loosening with the titanium stock abutment or titanium CAD/CAM abutment, highlighting that the connection of the CAD/CAM abutment to the fixture was as stable as that of the stock abutment [41]. Therefore, good stability of the screw joint could be achieved by performing a precise examination of the CAD/CAM abutments [24]. However, it must be considered that, in the research by Paek and colleagues [41], a dynamical force from 10 N to 250 N has been applied, which is much lower with respect to the masticatory forces that humans can apply, ranging between 300 and 500 N [55]; therefore, further studies are aimed at evaluating the mechanical behavior of CAD/CAM abutments also under maximum load conditions.

Regarding the precision of the implant–abutment connection between the CAD/CAM and stock abutments, the study by Apicella et al. [44] was the only one to date performed in which the fit was investigated by radiography and scanning electron microscopy (SEM). The results showed that the fit achievable with CAD/CAM abutments was comparable to that of the stock abutments.

In vitro studies on stock titanium abutments showed a significantly higher volume of material involved in the implant–abutment connection than CAD/CAM titanium abutments [42]. In fact, the frictional fit achieved with the stock abutment is better than the CAD/CAM abutment connected to the same implant system [43].

Finally, it has been reported that micromotion at the implant–abutment interface, a major determinant of long-term implant success, since technical problems related to screw loosening and a subsequent fracture may be due to excessive micromotion, does not present significant differences between zirconia CAD/CAM abutments and titanium stock abutments [48].

Based on the most recent literature, it is possible to assert that the use of CAD/CAM abutments has more advantages than stock abutments, both mechanical and aesthetic. From the in vitro studies performed to date, there are some common features, such as mechanical resistance to dynamic cycling, radiographic fit, and micromotion at the implant–abutment interface. However, some inherent advantages of using non-individualized abutments persist, such as time and cost, although some recent in vitro studies have shown mechanical advantages over one-piece CAD/CAM abutments and a better implant–abutment connection.

A summary table of the advantages and common aspects of CAD/CAM and stock abutments included in this work is shown in Table 2.

Table 2. Summary table of the advantages and equalities of CAD/CAM and stock abutments.

CAD/CAM Abutments Advantages	References and Study Details
CAD/CAM abutments containing titanium inserts had higher fracture resistance than solid zirconia abutment; this conditioned the type of fracture, mainly horizontal, and the location of the fracture, mainly buccal, distant from the implant platform.	Chang et al. 2022 [31]: in vitro investigation comparing three groups of zirconia abutments (n = 5) consisting of different connection designs or manufacturers (All-Zr, ASC-Zr, and AM-Zr groups)
All prosthetic parameters are modifiable, including emergence file, thickness, outer contour, position of the finish line in relation to the roots of contiguous tooth elements and the gingival margin, predictable fit, and durability.	Cantieri Mello et al. 2019 [36]: systematic review and meta-analysis of 11 in vitro studies
After 1 year of clinical service, no difference in fracture toughness was found for the CAD/CAM zirconia abutments compared with their pristine copies.	Schepke et al. 2019 [30]: ex vivo study on 23 stock and 23 CAD/CAM customized zirconia implant abutments
Two-piece CAD/CAM zirconia abutments with an internal–hex connection demonstrated greater fracture resistance than one-piece CAD/CAM zirconia and stock zirconia abutments.	Gehrke et al. 2015 [32]: in vitro experiments on 21 abutment-crown specimens Mostafavi et al. 2021 [29]: randomized clinical trial with 50 participants
Excellent finish, compensates poor implant angulation, and supports and interacts with soft tissue.	Valsan et al. 2021 [27]: clinical report
CAD/CAM healing abutments require fewer steps for prosthetic finalization than standard healing abutments, allow for a higher functional implant prosthodontics score, and perceived pain is less in the early stages of prosthetic rehabilitation.	Beretta et al. 2019 [38]: randomized controlled clinical trial with 20 participants
Screw-retained implant crowns based on CAD/CAM zirconia abutments with conical connection exhibited excellent clinical performance.	Fonseca et al. 2021 [33]: prospective cohort study, with a 4.5–8.8-year follow-up on 32 patients with 40 implant single crowns
CAD/CAM abutment-supported restorations in titanium and zirconia have lower mean papillary recession index than stock abutments, improving papilla support and avoid excessive papilla compression.	Lops et al. 2017 [35] and Lops et al., 2015 [37]: 2-year prospective multicenter cohort studies
Reduction of the risk of cement remaining deep in the peri-implant sulcus in the cemented prosthesis.	Edelhoff et al. 2019 [26]: review
Abutment material does not determine any significant difference in the degree of papillary recession for either stock abutments or CAD/CAM abutments made of titanium and zirconia, given the biocompatibility of these materials.	Haugen et al. 2022 [39]: review and meta-analysis respectively including 100 and 30 studies
Stock abutments advantages	
One-piece CAD/CAM zirconia abutments have lower static fracture loads than their stock counterparts.	Alsahhaf et al. 2017 [34]: in vitro study on 80 abutments Jarman et al. 2017 [45]: in vitro study on zirconia abutments Yilmaz et al. 2015 [46]: in vitro study comparing load to failure for 5 zirconia abutments for an internally hexagon implant

Table 2. *Cont.*

The volume of material involved in the implant-abutment connection is higher than CAD/CAM titanium abutments and the frictional fit achieved with the stock abutment is better than the CAD/CAM abutment connected to the same implant system.	Lops et al. 2018 [42]: in vitro study comparing 10 CAD/CAM titanium abutments with 10 stock titanium abutments Alonso-Pérez et al. 2017 [43]: in vitro study comparing 13 implants connected to original stock abutments and 13 implants connected to nonoriginal laser-sintered abutments
Better internal fit with respect to CAD/CAM abutments	Lops et al. 2018 [42]: in vitro study comparing 10 CAD/CAM titanium abutments with 10 stock titanium abutments Apicella et al. 2010 [44]: radiographic and SEM analysis on 12 titanium abutments, 12 stock zirconia abutments, and 12 third party zirconia abutments
Less risk of corrosion due to the possible use of different alloys in the milled parts; less time-consuming and expensive.	Ragupathi et al. 2020 [56]: in vitro study on 10 titanium abutments and 10 PEEK abutments Souza et al. 2020 [57]: review
Industrial manufacturing process standardizes the quality of the product and ensuring the use of biocompatible materials in the abutment/soft tissue interface.	Mostafavi et al. 2021 [28]: literature review
Common aspects	
After application of 5000 cycles of cyclic loading, with a force between 10 N and 250 N, there is no significant difference in screw loosening with titanium stock abutment or titanium CAD/CAM abutment, highlighting that the connection of the CAD/CAM abutment to the fixture was as stable as that of the stock abutment.	Paek et al. 2016 [41]: in vitro study on stock and customized CAD/CAM abutments
Micromotion at the implant-abutment interface does not present significant differences between zirconia CAD/CAM abutments and titanium stock abutments.	Karl and Taylor 2014 [48]: in vitro study on CAD/CAM zirconia and CAD/CAM titanium abutments
Radiographic and scanning electron microscopy (SEM) investigations have shown that the fit achievable with CAD/CAM abutments is comparable to that of stock abutments.	Apicella et al. 2010 [44]: radiographic and SEM analysis on 12 titanium abutments, 12 stock zirconia abutments, and 12 third party zirconia abutments
Two-piece CAD/CAM zirconia abutments are an equivalent alternative to titanium abutments in a single-implant restoration in the anterior region.	Wittneben et al. 2020 [47]: 3-year randomized clinical trial
After dynamic loading, microgap values at the implant-abutment interface are equivalent, demonstrating that CAD/CAM zirconia abutments can withstand functional forces as well as stock titanium abutments.	Coray et al. 2016 [40]: systematic review and meta-analysis on 7 studies

The present report presents some limitations. It is possible that the search methodology did not take into account all the articles in the literature, with particular reference to the gray literature and unindexed research. Moreover, these results may be different depending on the population considered. Most of the articles currently in the literature are in vitro studies, so there is a lack of clinical evidence. Another limitation is that CAD/CAM abutments can be realized in the same factory as the implants or by other companies; since it is not always specified in the articles, this aspect should be inserted, as it was demonstrated that some differences can occur between them [58]. Finally, the heterogeneity within CAD/CAM and stock abutments complicates the comparison between them; while CAD/CAM abutments may use the same materials as stock abutments, many materials may be used for CAD/CAM abutments; therefore, it may be difficult to get a general comment/generalizability on this topic.

Future research perspectives could include further randomized controlled clinical trials that should be conducted to evaluate the advantages reported to date, following in vitro studies, of using titanium and/or zirconia stock abutments.

5. Conclusions

The advantages of using CAD/CAM abutments are many and exceed the advantages of using stock abutments.

CAD/CAM abutments allow the clinician to individualize the abutment parameters in implant rehabilitation, respecting the soft tissue and maintaining excellent mechanical characteristics.

However, some advantages associated with the use of stock abutments remain, such as the risk of corrosion, time spent, cost, and in vitro assessed fit of the implant–abutment connection. The accuracy of the latter advantage will need to be evaluated clinically.

Author Contributions: Conceptualization, F.S., C.M. and A.S.; methodology, A.S., F.S. and C.M.; software, A.S. and M.M.; validation, S.G., M.M. and M.P. (Maurizio Pascadopoli); formal analysis, C.M., F.S. and A.S.; investigation, M.M. and C.M.; resources, S.G., F.S. and F.P.; data curation, P.Z., F.S. and A.S.; writing—original draft preparation, M.P. (Maurizio Pascadopoli), M.M. and M.P. (Matteo Pellegrini); writing—review and editing, A.S., F.S. and P.Z.; visualization, A.S., F.S. and C.M.; supervision, A.S. and C.M.; and project administration, F.S. and C.M. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Upon request to the corresponding author, the data are available for use.

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

References

1. Tischler, M. The Future of Implant Dentistry. *Dent. Today* **2016**, *35*, 84–85. [PubMed]
2. Ogawa, T.; Sitalaksmi, R.M.; Miyashita, M.; Maekawa, K.; Ryu, M.; Kimura-Ono, A.; Suganuma, T.; Kikutani, T.; Fujisawa, M.; Tamaki, K.; et al. Effectiveness of the socket shield technique in dental implant: A systematic review. *J. Prosthodont. Res.* **2022**, *66*, 12–18. [CrossRef] [PubMed]
3. Sisler, Z. More Than Just a Temporary Solution, Precise Provisionals Are the Key to Final Restorations. *Compend. Contin. Educ. Dent.* **2021**, *42*, 70–75. [PubMed]
4. Enkling, N.; Marder, M.; Bayer, S.; Götz, W.; Stoilov, M.; Kraus, D. Soft tissue response to different abutment materials: A controlled and randomized human study using an experimental model. *Clin. Oral Implants Res.* **2022**, *33*, 667–679. [CrossRef] [PubMed]
5. Rameh, S.; Menhall, A.; Younes, R. Key factors influencing short implant success. *Oral Maxillofac. Surg.* **2020**, *24*, 263–275. [CrossRef] [PubMed]
6. Shokouhi, B.; Cerajewska, T. Radiotherapy and the survival of dental implants: A systematic review. *Br. J. Oral Maxillofac. Surg.* **2022**, *60*, 422–429. [CrossRef] [PubMed]
7. Huang, R.; Li, M.; Gregory, R.L. Bacterial interactions in dental biofilm. *Virulence* **2014**, *2*, 435–444. [CrossRef] [PubMed]
8. Romanos, G.E.; Weitz, D. Therapy of peri-implant diseases. Where is the evidence? *J. Evid. Based Dent. Pract.* **2012**, *12*, 204–208. [CrossRef]
9. Butera, A.; Pascadopoli, M.; Pellegrini, M.; Gallo, S.; Zampetti, P.; Scribante, A. Oral Microbiota in Patients with Peri-Implant Disease: A Narrative Review. *Appl. Sci.* **2022**, *12*, 3250. [CrossRef]
10. Belibasakis, G.N.; Manoil, D. Microbial Community-Driven Etiopathogenesis of Peri-Implantitis. *J. Dent. Res.* **2021**, *100*, 21–28. [CrossRef]
11. Mombelli, A. Microbial colonization of the periodontal pocket and its significance for periodontal therapy. *Periodontology 2000* **2018**, *76*, 85–96. [CrossRef]
12. Feres, M. Antibiotics in the treatment of periodontal diseases: Microbiological basis and clinical applications. *Ann. R. Australas. Coll. Dent. Surg.* **2008**, *19*, 37–44. [PubMed]
13. Tonon, C.C.; Panariello, B.H.D.; Spolidorio, D.M.P.; Gossweiler, A.G.; Duarte, S. Antibiofilm effect of ozonized physiological saline solution on peri-implant-related biofilm. *J. Periodontol.* **2021**, *92*, 1151–1162. [CrossRef] [PubMed]
14. Poli, P.P.; Cicciu, M.; Beretta, M.; Maiorana, C. Peri-Implant Mucositis and Peri-Implantitis: A Current Understanding of Their Diagnosis, Clinical Implications, and a Report of Treatment Using a Combined Therapy Approach. *J. Oral Implantol.* **2017**, *43*, 45–50. [CrossRef] [PubMed]
15. Poli, P.P.; Souza, F.Á.; Manfredini, M.; Maiorana, C.; Beretta, M. Regenerative treatment of peri-implantitis following implant surface decontamination with titanium brush and antimicrobial photodynamic therapy: A case series with reentry. *J. Oral Implantol.* **2020**, *46*, 619–626. [CrossRef] [PubMed]

16. Invernici, M.M.; Salvador, S.L.; Silva, P.; Soares, M.; Casarin, R.; Palioto, D.B.; Souza, S.; Taba, M., Jr.; Novaes, A.B., Jr.; Furlaneto, F.; et al. Effects of Bifidobacterium probiotic on the treatment of chronic periodontitis: A randomized clinical trial. *J. Clin. Periodontol.* **2018**, *45*, 1198–1210. [CrossRef] [PubMed]
17. Hardan, L.; Bourgi, R.M.; Cuevas-Suárez, C.E.; Flores-Rodríguez, M.; Omaña-Covarrubias, A.; Nicastro, M.; Lazarescu, F.; Zarow, M.; Monteiro, P.; Jakubowicz, N.; et al. The Use of Probiotics as Adjuvant Therapy of Periodontal Treatment: A Systematic Review and Meta-Analysis of Clinical Trials. *Pharmaceutics* **2022**, *14*, 1017. [CrossRef]
18. Butera, A.; Pascadopoli, M.; Pellegrini, M.; Gallo, S.; Zampetti, P.; Cuggia, G.; Scribante, A. Domiciliary Use of Chlorhexidine vs Postbiotic Gels in Patients with Peri-Implant Mucositis: A Split-Mouth Randomized Clinical Trial. *Appl. Sci.* **2022**, *12*, 2800. [CrossRef]
19. Paniz, G.; Mazzocco, F. Surgical-prosthetic management of facial soft tissue defects on anterior single implant-supported restorations: A clinical report. *Int. J. Esthet. Dent.* **2015**, *10*, 270–284.
20. Cabello, G.; Rioboo, M.; Fábrega, J.G. Immediate placement and restoration of implants in the aesthetic zone with a trimodal approach: Soft tissue alterations and its relation to gingival biotype. *Clin. Oral Implants Res.* **2013**, *24*, 1094–1100. [CrossRef]
21. Strietzel, F.P.; Neumann, K.; Hertel, M. Impact of platform switching on marginal peri-implant bone-level changes. A systematic review and meta-analysis. *Clin. Oral Implants Res.* **2015**, *26*, 342–358. [CrossRef] [PubMed]
22. Esteves, G.M.; Esteves, J.; Resende, M.; Mendes, L.; Azevedo, A.S. Antimicrobial and Antibiofilm Coating of Dental Implants-Past and New Perspectives. *Antibiotics* **2022**, *11*, 235. [CrossRef] [PubMed]
23. Kreve, S.; Dos Reis, A.C. Effect of surface properties of ceramic materials on bacterial adhesion: A systematic review. *J. Esthet. Restor. Dent.* **2022**, *34*, 461–472. [CrossRef] [PubMed]
24. Kim, E.-S.; Shin, S.-Y. Influence of the implant abutment types and the dynamic loading on initial screw loosening. *J. Adv. Prosthodont.* **2013**, *5*, 21–28. [CrossRef] [PubMed]
25. Sorrentino, R.; Leone, R.; Leuci, S.; Ausiello, P.; Zarone, F. CAD/CAM cobalt-chromium alloy single crowns in posterior regions: 4-year prospective clinical study. *J. Osseointegr.* **2017**, *9*, 282–288.
26. Edelhoff, D.; Schweiger, J.; Prandtner, O.; Stimmelmayr, M.; Güth, J.-F. Metal-free implant-supported single-tooth restorations. Part I: Abutments and cemented crowns. *Quintessence Int.* **2019**, *50*, 176–184.
27. Valsan, I.M.; Pauna, M.R.; Petre, A.E.; Oancea, L. Biologic and Esthetic Outcome of CAD/CAM Custom Ceramic Implant Abutment: A Clinical Report. *Maedica* **2021**, *16*, 145–148.
28. Mostafavi, A.S.; Mojtahedi, H.; Javanmard, A. Hybrid Implant Abutments: A Literature Review. *Eur. J. Gen. Dent.* **2021**, *10*, 106–115. [CrossRef]
29. Schepke, U.; Meijer, H.J.A.; Kerdijk, W.; Raghoebar, G.M.; Cune, M. Stock Versus CAD/CAM Customized Zirconia Implant Abutments—Clinical and Patient-Based Outcomes in a Randomized Controlled Clinical Trial. *Clin. Implants Dent. Relat. Res.* **2017**, *19*, 74–84. [CrossRef]
30. Schepke, U.; Gresnigt, M.M.M.; Browne, W.R.; Abdolahzadeh, S.; Nijkamp, J.; Cune, M.S. Phase transformation and fracture load of stock and CAD/CAM-customized zirconia abutments after 1 year of clinical function. *Clin. Oral Implants Res.* **2019**, *30*, 559–569. [CrossRef]
31. Chang, Y.-T.; Wu, Y.-L.; Chen, H.-S.; Tsai, M.-H.; Chang, C.-C.; Wu, A.Y.-J. Comparing the Fracture Resistance and Modes of Failure in Different Types of CAD/CAM Zirconia Abutments with Internal Hexagonal Implants: An In Vitro Study. *Materials* **2022**, *15*, 2656. [CrossRef] [PubMed]
32. Gehrke, P.; Johannson, D.; Fischer, C.; Stawarczyk, B.; Beuer, F. In vitro fatigue and fracture resistance of one- and two-piece CAD/CAM zirconia implant abutments. *Int. J. Oral Maxillofac. Implants* **2015**, *30*, 546–554. [CrossRef] [PubMed]
33. Fonseca, M.; Molinero-Mourelle, P.; Forrer, F.A.; Schnider, N.; Hicklin, S.P.; Schimmel, M.; Brägger, U. Clinical performance of implant crowns with customized zirconia abutments: A prospective cohort study with a 4.5- to 8.8-year follow-up. *Clin. Oral Implants Res.* **2021**, *32*, 853–862. [CrossRef]
34. Alsahhaf, A.; Spies, B.C.; Vach, K.; Kohal, R.-J. Fracture resistance of zirconia-based implant abutments after artificial long-term aging. *J. Mech. Behav. Biomed. Mater.* **2017**, *66*, 224–232. [CrossRef] [PubMed]
35. Lops, D.; Parpaiola, A.; Paniz, G.; Sbricoli, L.; Magaz, V.R.; Venezze, A.C.; Bressan, E.; Stellini, E. Interproximal Papilla Stability Around CAD/CAM and Stock Abutments in Anterior Regions: A 2-Year Prospective Multicenter Cohort Study. *Int. J. Periodontics Restor. Dent.* **2017**, *37*, 657–665. [CrossRef] [PubMed]
36. Cantieri Mello, C.; Araujo Lemos, C.A.; Ramos Verri, F.; Piza Pelizzer, E. CAD/CAM vs Conventional Technique for Fabrication of Implant-Supported Frameworks: A Systematic Review and Meta-Analysis of in Vitro Studies. *Int. J. Prosthodont.* **2019**, *32*, 182–192. [CrossRef] [PubMed]
37. Lops, D.; Bressan, E.; Parpaiola, A.; Sbricoli, L.; Cecchinato, D.; Romeo, E. Soft tissues stability of cad-cam and stock abutments in anterior regions: 2-year prospective multicentric cohort study. *Clin. Oral Implants Res.* **2015**, *26*, 1436–1442. [CrossRef]
38. Beretta, M.; Poli, P.P.; Pieriboni, S.; Tansella, S.; Manfredini, M.; Ciccù, M.; Maiorana, C. Peri-Implant Soft Tissue Conditioning by Means of Customized Healing Abutment: A Randomized Controlled Clinical Trial. *Materials* **2019**, *12*, 3041. [CrossRef]
39. Haugen, H.J.; Chen, H. Is There a Better Biomaterial for Dental Implants than Titanium?—A Review and Meta-Study Analysis. *J. Funct. Biomater.* **2022**, *13*, 46. [CrossRef]
40. Coray, R.; Zeltner, M.; Õzcan, M. Fracture strength of implant abutments after fatigue testing: A systematic review and a meta-analysis. *J. Mech. Behav. Biomed. Mater.* **2016**, *62*, 333–346. [CrossRef]

41. Paek, J.; Woo, Y.-H.; Kim, H.-S.; Pae, A.; Noh, K.; Lee, H.; Kwon, K.-R. Comparative Analysis of Screw Loosening with Prefabricated Abutments and Customized CAD/CAM Abutments. *Implant Dent.* **2016**, *25*, 770–774. [CrossRef] [PubMed]
42. Lops, D.; Meneghello, R.; Sbricoli, L.; Savio, G.; Bressan, E.; Stellini, E. Precision of the Connection Between Implant and Standard or Computer-Aided Design/Computer-Aided Manufacturing Abutments: A Novel Evaluation Method. *Int. J. Oral Maxillofac. Implants* **2018**, *33*, 23–30. [CrossRef] [PubMed]
43. Alonso-Pérez, R.; Bartolomé, J.F.; Ferreiroa, A.; Salido, M.P.; Pradíes, G. Evaluation of the Mechanical Behavior and Marginal Accuracy of Stock and Laser-Sintered Implant Abutments. *Int. J. Prosthodont.* **2017**, *30*, 136–138. [CrossRef] [PubMed]
44. Apicella, D.; Veltri, M.; Chieffi, N.; Polimeni, A.; Giovannetti, A.; Ferrari, M. Implant adaptation of stock abutments versus CAD/CAM abutments: A radiographic and Scanning Electron Microscopy study. *Ann. Stomatol. (Roma)* **2010**, *1*, 9–13.
45. Jarman, J.M.; Hamalian, T.; Randi, A.P. Comparing the Fracture Resistance of Alternatively Engineered Zirconia Abutments with Original Equipment Manufactured Abutments with Different Implant Connection Designs. *Int. J. Oral Maxillofac. Implants* **2017**, *32*, 992–1000. [CrossRef]
46. Yilmaz, B.; Salaita, L.G.; Seidt, J.D.; McGlumphy, E.A.; Clelland, N.L. Load to failure of different zirconia abutments for an internal hexagon implant. *J. Prosthet. Dent.* **2015**, *114*, 373–377. [CrossRef]
47. Wittneben, J.-G.; Gavric, J.; Sailer, I.; Buser, D.; Wismeijer, D. Clinical and esthetic outcomes of two different prosthetic workflows for implant-supported all-ceramic single crowns-3 year results of a randomized multicenter clinical trail. *Clin. Oral Implants Res.* **2020**, *31*, 495–505. [CrossRef]
48. Karl, M.; Taylor, T.D. Parameters determining micromotion at the implant-abutment interface. *Int. J. Oral Maxillofac. Implants* **2014**, *29*, 1338–1347. [CrossRef]
49. Stevens, F.W. Construction of an acrylic resin dowel crown to be used as an abutment for a fixed bridge. *Dent. Surv.* **1945**, *21*, 1779–1782.
50. Harris, F.N. The precision dowel rest attachment. *J. Prosthet. Dent.* **1955**, *5*, 43–48. [CrossRef]
51. Miyakawa, O. Mechanical studies on the dental bridges by the finite element method. (1)—An abutment tooth model. *Shika Rikogaku Zasshi* **1976**, *17*, 269–277. [PubMed]
52. Hiroshi, A.; Yasuhiro, K.; Yuzo, M.; Hiroshi, K.; Junzo, T.; Masao, K.; Takashi, W. A Method for Machining Free Formed Surface by using a CAD/CAM System by a Personal Computer and an Optical Measurement of Object Shapes. (1st Report):-Optical Profile NC Machining-. *J. JSPE* **1989**, *55*, 1259–1264.
53. Edelhoff, D.; Schweiger, J.; Prandtner, O.; Stimmelmayr, M.; Güth, J.-F. Metal-free implant-supported single-tooth restorations. Part II: Hybrid abutment crowns and material selection. *Quintessence Int.* **2019**, *50*, 260–269. [PubMed]
54. Naveau, A.; Rignon-Bret, C.; Wulfman, C. Zirconia abutments in the anterior region: A systematic review of mechanical and esthetic outcomes. *J. Prosthet. Dent.* **2019**, *121*, 775–781.e1. [CrossRef]
55. Bates, J.F.; Stafford, G.D.; Harrison, A. Masticatory function—A review of the literature. III. Masticatory performance and efficiency. *J. Oral Rehabil.* **1976**, *3*, 57–67. [CrossRef]
56. Ragupathi, M.; Mahadevan, V.; Azhagarasan, N.S.; Ramakrishnan, H.; Jayakrishnakumar, S. Comparative evaluation of the wear resistance of two different implant abutment materials after cyclic loading—An in vitro study. *Contemp. Clin. Dent.* **2020**, *11*, 229–236.
57. Souza, J.C.M.; Apaza-Bedoya, K.; Benfatti, C.A.M.; Silva, F.S.; Henriques, B. A Comprehensive Review on the Corrosion Pathways of Titanium Dental Implants and Their Biological Adverse Effects. *Metals* **2020**, *10*, 1272. [CrossRef]
58. Karl, M.; Irastorza-Landa, A. In Vitro Characterization of Original and Nonoriginal Implant Abutments. *Int. J. Oral Maxillofac. Implants* **2018**, *33*, 1229–1239. [CrossRef]