CAD/CAM Abutments versus Stock Abutments

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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.

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

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].

2. CAD/CAM Abutments versus Stock Abutments

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 [19][20].

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 [21]. 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 [22]. 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 [23].

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 [24]. 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 [25].

However, the prospective cohort study by Fonseca et al. [26], 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 [27].

Regarding peri-implant soft tissues, Lops et al. [28] 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 [29]. For these reasons, a CAD/CAM abutment could improve the papilla support and avoid excessive papilla compression [30]. 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.

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 [31].

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 [32]. Therefore, good stability of the screw joint could be achieved by performing a precise examination of the CAD/CAM abutments [33]. However, it must be considered that, in the research by Paek and colleagues [32], 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 [34]; 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. [35] 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 [36]. In fact, the frictional fit achieved with the stock abutment is better than the CAD/CAM abutment connected to the same implant system [37].

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 [38].

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 1**.

Table 1. 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 [39]: 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 [29]: 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 [40]: 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 [41]: in vitro experiments on 21 abutment-crown specimens Mostafavi et al. 2021 [23]: randomized clinical trial with 50 participants
Excellent finish, compensates poor implant angulation, and supports and interacts with soft tissue.	Valsan et al. 2021 [21]: 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 [42]: 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 [26]: 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 [28] and Lops et al., 2015 [30]: 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 [19]: 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 [31]: review and meta-analysis respectively including 100 and 30 studies
Stock abutments advantages	

CAD/CAM Abutments Advantages	References and Study Details
One-piece CAD/CAM zirconia abutments have lower static fracture loads than their stock counterparts.	Alsahhaf et al. 2017 [25]: in vitro study on 80 abutments Jarman et al. 2017 [43]: in vitro study on zirconia abutments Yilmaz et al. 2015 [44]: in vitro study comparing load to failure for 5 zirconia abutments for an internally hexagon implant
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 [36]: in vitro study comparing 10 CAD/CAM titanium abutments with 10 stock titanium abutments Alonso-Pérez et al. 2017 [37]: 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 [36]: in vitro study comparing 10 CAD/CAM titanium abutments with 10 stock titanium abutments Apicella et al. 2010 [35]: 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 [45]: in vitro study on 10 titanium abutments and 10 PEEK abutments Souza et al. 2020 [46]: 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 [22]: 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 [32]: 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 [38]: in vitro study on CAD/CAM zirconia and CAD/CAM titanium abutments

CAD/CAM Abutments Advantages	References and Study Details
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 [35]: 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 [24]: 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 [27]: systematic review and meta-analysis on 7 studies

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