Review Article

Original versus Non-Original Dental Implant Abutments: A Systematic Review

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Abstract

Background and Aim: Abutment selection is an important decision to make in the dental implant treatments. The prohibitive cost and unavailability of original abutments have driven many practitioners to opt for choosing compatible abutments alternatively. However, the use of non-original and low-quality abutments may lead to a myriad of complications for the patients. The current research was conducted with the aim of comparing original and non-original abutments in dental implant treatments.

Materials and Methods: A total of 46 review articles were selected and evaluated from articles published between 2001 and 2022. The search was performed in various electronic databases including PubMed, Science Direct, and Google Scholar. The search utilized keywords such as "abutment," "original abutment," "non-original abutment," "main abutment," "non-main abutment," and "compatible abutment." Data were meticulously collected on several parameters, including fit accuracy, microleakage, bacterial leakage, micromotion, rotational misalignment, screw loosening, fracture resistance, fatigue resistance, tensile strength, marginal accuracy, and other mechanical outcomes.

Results: The results showed that, the original abutments had more appropriate accuracy, more micro-movement, and fatigue resistance compared to non-original abutments, and they were more durable. In addition, original abutments provided a lower percentage of torque reduction and lower values for screw loosening than non-original examples. The mean micro-gap at the implant-abutment interface, bacterial leakage, and rotational misalignment were higher in non-original abutments. The findings showed that the incidence of mechanical failure was lower for original abutments and its marginal accuracy was higher.

Conclusion: Although non-original abutments may visually resemble original ones, significant differences exist in their physical and mechanical properties. These discrepancies can be identified through advanced testing methods.

Key Words: Abutment, Compatible abutment, Implant, Non-original abutment, Original abutment

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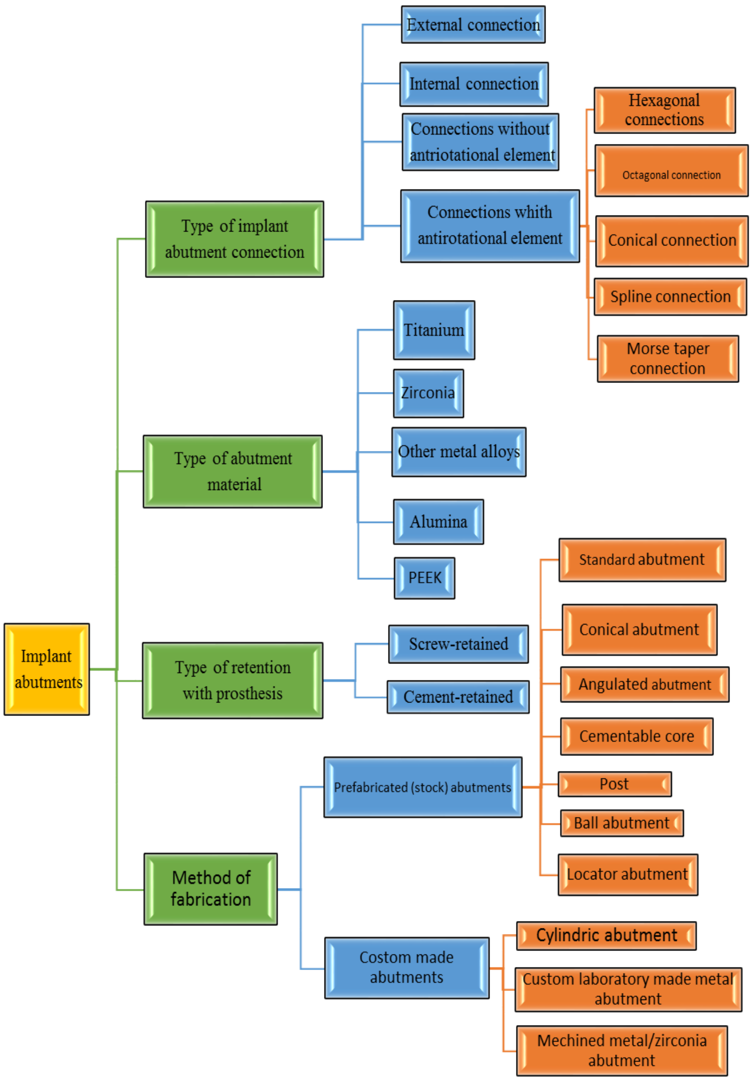
Introduction

Dental implants have a substantial ability to restore both the aesthetic appearance and functional capabilities of lost teeth. Consequently, the increasing demand for dental implants has prompted numerous manufacturers to enter this industry [1]. In this realm, various brands of implants and their components are available in the market, each differing in design and other characteristics. [2]. Generally, an implant consists of three components; the implant base or fixture, the dental crown (veneer, artificial tooth or bridge), and the abutment. The abutment is positioned between the implant base and the dental crown, acting as a support or holder for the dental prosthesis, which extends deeply into the soft tissue [3]. Therefore, the abutment material must be tissue-compatible. At present, abutments are made from materials such as titanium, zirconium, aluminum, PEEK, gold alloys, and various other metal alloys. Apart from biocompatibility, these materials must have ideal mechanical properties to tolerate the occlusal load and survive in the oral environment [2]. Therefore, selecting the abutment with precision is crucial for the optimal function of the implant prosthesis. To select the appropriate abutment, practitioners must possess a comprehensive knowledge about various types of abutments and the factors influencing their selection. These abutments are different in the implant-abutment interface, material, type of maintenance, and manufacturing methods [2].

Non-original abutments (NOAs) in dentistry, particularly in implantology, refer to abutments that are not manufactured by the original equipment manufacturer (OEM) of the dental implant. They are often used as alternatives to original abutments (OAs) due to factors such as availability, cost, or specific clinical requirements. In general, NOAs are used by dentists in three situations: 1) unavailability of original implant components, 2) lack of physician's knowledge regarding the brand of implant to be restored, and 3) cost saving [4, 5]. The use of low-quality and NOAs may cause many problems for patients. For example, increased distance between the original implant and compatible abutment interfaces due to cyclic occlusal loading during physiological function may cause microbial leakage [6, 7]. This leads to bacterial colonization through the formation of plaque at the interface of the implant-abutment complex, leading to peri-implant disease, bone resorption, and finally implant failure [8]. There are different classifications for abutments in terms of material, connection method, manufacturing method, etc. The different types of abutments are shown in Flow chart 1.



Flow Chart 1: Classification of implant abutments [9].

Since implants are highly expensive, they are not commonly restored with NOAs [10]. Meanwhile, few clinical studies have investigated the characteristics of NOAs and compared it with the OAs [11]. For example, in a study, Alonso-Pérez et al. (2021) investigated the interface of OA-implant versus NOA-implant of gypsum-to-gold. The aim of this *in vitro* study was to evaluate the internal fit and cyclic fatigue life after artificial aging of 3 reconstructed implant-abutment configurations with 1 OA and 2 gypsum-to-gold NOAs [12]. In another study, Gigandet et al. compared implants with original and NOA interfaces. The purpose of this study was to test the mechanical resistance, rotational misalignment, and failure mode of three main implant-abutment interfaces under *in vitro* conditions and compare them with two connections between NOAs connected to one of the original implants [13].

In this regard, Alonso-Pérez et al. compared the OA-to-implant interface in terms of internal accuracy and mechanical fatigue behavior with a compatible abutment *in vitro*. The authors further evaluated the internal accuracy and mechanical behavior under cyclic loading after artificial aging of implant abutment veneers reconstructed with OAs and two compatible NOAs. In this study, forty-eight original internal hexagonal implants were attached to different stock abutments. First, the samples were cross-sectionally cut and observed using a Scanning Electron Microscope (SEM) to evaluate the internal accuracy of three different samples. Furthermore, cyclic fatigue loading was performed according to the ISO 14801 standard using a dynamic testing machine [10]. Silva et al. compared the mechanical resistance to maximum torsional stress in original and non-original or compatible prosthesis implant screws during an *in vitro* study as well [14]. Tallarico et al. investigated the mechanical results, microleakage, and marginal accuracy at the implant-abutment interface in OAs and NOAs [4]. The *in vitro* characteristics of OAs and NOAs were also studied by Karl et al., who investigated these characteristics based on parameters such as dimensional accuracy, gap formation, circumferential strain, abutment screw preload, micromotion, abutment settlement, mean fatigue limit, and bacterial leakage [15].

Studies show that the distance between the implant and the abutment causes chronic inflammatory reactions because it allows the movements of acids, enzymes, bacteria, or their metabolic products [16]. Some studies have shown that the use of compatible abutments may increase the micro-movements between the abutments and the internal part of the implant which may increase the stress on the marginal bone surface. Moreover, micro-movement alters the volume of the internal space of the implant-abutment complex, facilitating inward and outward transfer of primary immovable microorganisms [6, 17]. In this regard, Berberi et al. addressed the micromovement of the original and compatible abutments in the implant-abutment interface. The authors evaluated the mechanical housing of OsseoSpeed™ Tx implants related to original and compatible abutments *in vitro* under simulated clinical loading conditions. In this study, the existing micro gap in width and length between the implant and abutment was evaluated [18]. Figure 1 shows micrographs of implant-abutment micro-gap differences shown under SEM before cyclic loading. Figure 2 also shows Co–CrMill abutment, SEM misfit assessment scheme, and micro-gap measurement concept. In another study, Berberi et al. compared the marginal and internal fit at the implant-abutment interface in OAs and NOAs. In this regard, twenty implants were assembled with four different types of abutments that had the same conical internal connection. Then, the implant-abutment assembly was embedded in the resin and ground in the meso-distal direction of the abutment edge using a diamond disc at a very low speed with cool water, and the average width of the gap in different abutments was investigated [19]. Duraisamy et al. in a study evaluated the micro-gap in the implant-abutment interface with OAs and NOAs. In this study, 20 titanium implants including ten OAs and ten NOAs were embedded in auto-polymerized clear acrylic resin blocks.

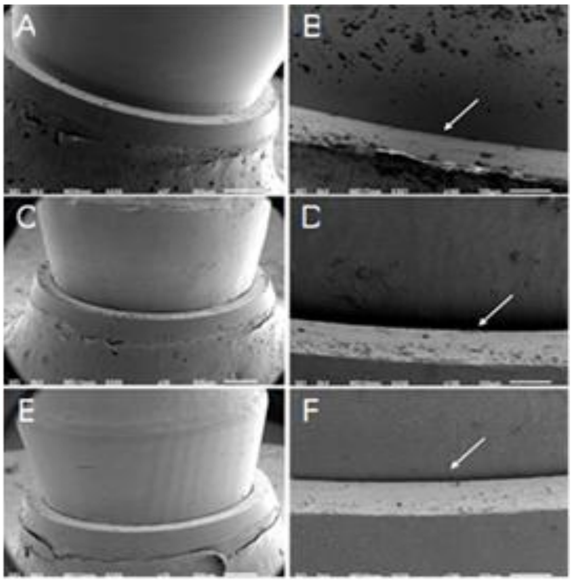


Figure 1. Micrographs of implant-abutment micro-gap discrepancy shown under SEM before cyclic loading. Macroscopic images were taken at 30X and at higher magnification at 1000X, with machined (A,B), cast (C,D), and milled (E,F). The arrows indicate the dimensions of the micro-gap [21]

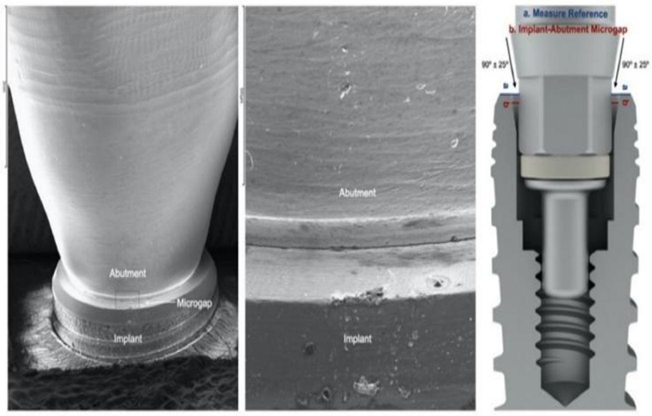


Figure 2. Co–CrMill abutment, SEM misfit assessment scheme, and microgap measurement concept [22]

After curing overnight, these blocks were cut vertically using a water jet cutter and evaluated under an SEM following sequential cleaning procedures. Micro-gaps in the implant-abutment interface for all specimens using the pixel counting software were measured [20]. Figure 3 shows the comparison of OAs and NOAs. Figure 4 also shows the rotational freedom between two suitable hexagonal parts-the implant neck and the abutment.

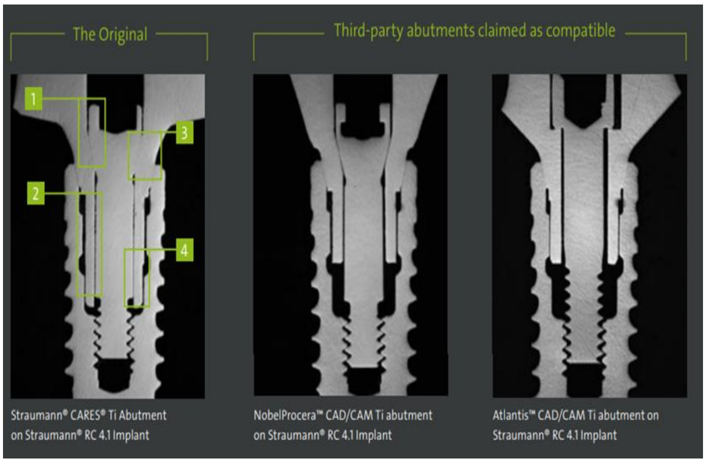


Figure 3. Comparison of original and NOAs [23]

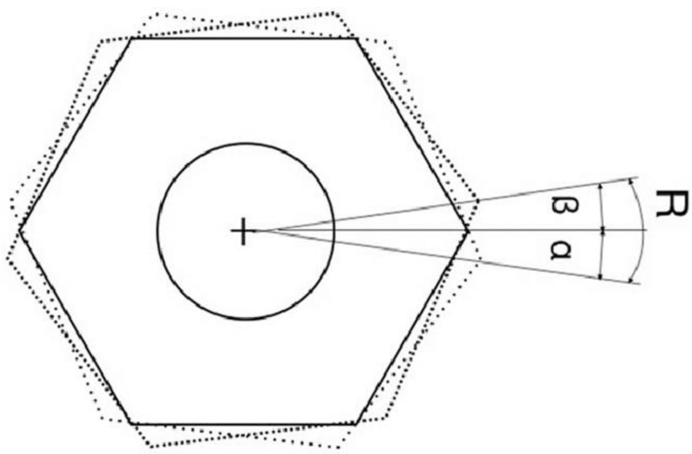


Figure 4. Rotational freedom between the two fitting hexagonal parts, the neck of the implant and the abutment. [24]

On the other hand, studies show that the implant-abutment interface (IAC) is a key factor for the success and long-term stability of implant-supported prosthetic restorations and surrounding tissues. The mismatch between prosthetic abutment and implant in IAC leads to technical and biological complications. As mentioned before, microbial leakage is also of great importance concerning abutments and implants. Previous *in vitro* work has shown that implants restored with NOAs are more susceptible to bacterial leakage, however, in most of the studies, this issue was statistically insignificant. For example, Ruddiman et al. compared the amount of bacterial leakage in OAs and NOAs in a study on animal (sheep). This study found no difference in microbial leakage between OAs and NOAs [25]. Similarly, Smojver et al. investigated the sealing effect of OAs and third-party custom-made abutments in an *in vitro* study. In this study, the internal fit (gap) in the implant-abutment interface was investigated depending on the abutment manufacturing method. The implant-abutment complex was infected with a solution containing *Staphylococcus aureus* and *Candida albicans* for 14 days under aerobic conditions. The results of this study did not show a statistically significant difference in microbial leakage between OAs and NOAs, regardless of the use of sealing materials [26]. Alonso-Pérez et al. also evaluated original and compatible abutments for fixed single-implant veneers in terms of gap, mechanical behavior, and screw loosening *in vitro* conditions [27]. In a systematic study, Rizvi et al. examined the accuracy of OAs versus NOAs using different connection geometries for single-unit restorations. This study was conducted to find out whether the compatibility of NOAs with dental implants is influenced by the type of implant attachment, i.e. internal or external or no attachment. Additionally, the study examines if certain combinations of components can be as compatible as the original components [28].

Research in the field of OAs versus NOAs in dental implants reveals several deficiencies that limit the understanding and application of findings. Many studies focus exclusively on *in vitro* conditions, which do not accurately replicate the complexities of the oral environment. This limitation affects the generalizability of the findings to real-world clinical scenarios. *In vitro* studies often lack comprehensive methodological details. Also, the absence of standardized testing methodologies and reporting parameters hinders the ability to compare findings across studies effectively. Establishing consistent protocols would enhance the reproducibility of results and facilitate more robust conclusions regarding the mechanical behavior and performance of OAs versus NOAs.

While some studies provide insights into the mechanical properties of abutments, there is a notable scarcity of long-term clinical data that assesses the performance of OAs versus NOAs over time. Most existing literature focuses on short-term outcomes, which may not adequately reflect the durability and reliability of these components in clinical practice.

It also showed the review of past studies, Current in vitro studies often fail to replicate the dynamic forces and biological interactions present in the oral cavity. Improvements are needed in the design of laboratory experiments to better mimic occlusal forces and parafunctional habits, which are critical for understanding the long-term behavior of abutment screws. There is a need for more direct comparative studies that evaluate the performance of OAs and NOAs under similar conditions. Many existing studies focus on one type of abutment without adequately comparing it to others, which limits the ability to draw comprehensive conclusions about their relative merits.

Addressing these deficiencies through improved study designs, standardized methodologies, and a focus on long-term clinical outcomes will enhance the understanding of the performance differences between OAs and NOAs. This will ultimately contribute to better clinical practices and outcomes in implant dentistry.

As mentioned, few studies have been conducted on the characteristics of OAs and NOAs. Most of these studies have been performed under *in vitro* conditions. This research aims to thoroughly examine and compare various characteristics of OAs and NOAs and will be conducted as a review, analyzing existing literature to identify differences and similarities between these two abutment types.

A summary of the studies conducted on the comparison of OAs and NOAs is given in Table 1.

Table 1. Studies conducted in the field of comparison of original and NOAs

The authors	number of samples	Abutment used	Conclusion
Alonso-Pérez et al. (2018)	63	21 people with OA and two groups of 21 people with NOA	OA-implant screws showed a lower percentage of torque reduction than non-original samples.
Smojver et al. (2022)	80 titanium dental implants	40 were GC Aadva Standard implants (GCTech.Europe GmbH, Breckerfeld, Germany), with a conical type of connection, and 40 were Zimmer Tapered Screw-Vent implants (Zimmer Biomet Dental, Palm Beach Gardens, FL, USA) with a straight type of connection. The implants were divided into two groups each, regarding the type of prosthetic abutment (A and B).	The results of this study showed that there is no statistically significant difference in microbial leakage between original and non-original custom abutments, regardless of the use of sealing materials.
Ruddiman et al. (2017)	60 animal sam-ples(sheep)	Six groups (n=10) were evaluated as follows: Delayed aftermarket abutment (A), delayed OEM abutment (B), immediate aftermarket abutment (C and D), immediate OEM abutment (E and F).	No difference in microbial leakage was observed between original and NOAs
Duraisamy et al. (2019)	20 titanium implants	Ten OAs and ten NOAs	The average micro gap in NOAs is higher than OAs
Berberi et al. (2016)	15 OsseoSpeed™ TX implants	group I: Five original Ti Design™ abutments, group II: Five Natea™ abutments, and group III: Implanet™ abutments	use of compatible components leads to significant micromovement when compared with the use of original ones .Clinically, the micromovements when associated with leakage leads to bone loss around the neck of the implant and later to peri-implantitis.
Berberi et al. (2022)	20	Ti DesignTM abutments (group A), DualTM abutments (group B), Natea plusTM abutments (group C) and ImplanetTM abutments (group D).	External and internal fit of components is better when using original components.
Karl et al. (2018)	60	Six groups of original and clone abutments compatible with NobelActive implants	All implant-abutment combinations showed microbial leakage after 6 days of incubation, which values were lower in OAs than NOAs.
Silva et al. (2021)	90	A total of 30 Mis Seven® standard platform implants and 30 interfaces were used, and 30 standard platform screws were tested, 10 Mis®, 10 Iconekt®, and 10 Exaktus.®	Nonoriginal screws did not present different fracture resistances compared to the original Mis® brand screws. The fracture site of Iconekt® screws showed a different pattern compared to the other brands.
Alonso-Pérez et al. (2022)	48	1 OA group and 2 non- OA groups	OA components presented the highest percentage of surface with tight contact with the implant in the three implant-abutment interfaces studied OA components provide better fit and mechanical results under cyclic loading than non-original configurations. The results obtained in this study seem to suggest that the use of the original stock abutments to implants leads to a more homogeneous load distribution between the components that can influence the long-term success of the restorations

Materials and Methods

In the present review article, various electronic databases such as PubMed, Science Direct, Google Scholar, Scopus, Medline, and Web of Science were used to search for articles related to original and non-original and compatible abutments published between 2001 and 2022. Keywords such as abutment, original abutment, non-original abutment, main abutment, non-main abutment, and compatible abutment were used in this research. The screening of articles was done in two stages. In this systematic review, to prevent and reduce bias, all authors screened the titles and abstracts of the articles, excluding any irrelevant studies. The bibliography of the selected articles was also manually searched to find related articles that may have been missed in the initial search [29]. After collecting the titles and summaries of the articles, each was evaluated based on the following criteria:

1. The title of the study must be relevant to the objectives of this review.
2. The summary of the article must indicate that the study pertains to the field of abutment research.
3. The study must be identified as an interventional analytical type.
4. The results obtained must align with the purpose of this review.

If any study's title and summary did not meet the above criteria, it was excluded. However, if the criteria were met or their presence was ambiguous, the full-text version of the article was obtained and reviewed. The exclusion criteria for articles included unclear information about patients, abutments, follow-up time, and study design; animal studies; case presentations or retrospective studies; lack of a control group; and review studies.

The quality of the selected studies was assessed using the Newcastle-Ottawa Scale checklist. According to this protocol, the following criteria were evaluated:

1. Correctness in selecting the study group.
2. Diagnosis of drug abuse and addiction based on DSM criteria.
3. Control of confounding factors, such as drug use and socio-economic factors.
4. Examination of the outcome, which included:
   - Assessment of oral and dental problems by an experienced researcher using calibrated tools.
   - Presence of clinical criteria for the mentioned problems.
   - Inclusion of control cases.
   - Reporting of non-response cases.

According to this protocol, a score of 0 to 8 was assigned to each study based on the presence of the above items, and these scores were recorded in the tables. Each study was graded by two researchers, and in case of a discrepancy between the scores, a third researcher reviewed the study. Finally, the articles were summarized and scored based on their final scores. They were classified into three categories: high quality (score 6-8), medium quality (score 3-5), and low quality (score 0-2). Only the high-quality articles (score 6-8) were retained in the study, while the medium and low-quality articles were excluded.

In total, 46 completely related articles that were suitable for review and comparison were retrievd and evaluated (Figure 5).

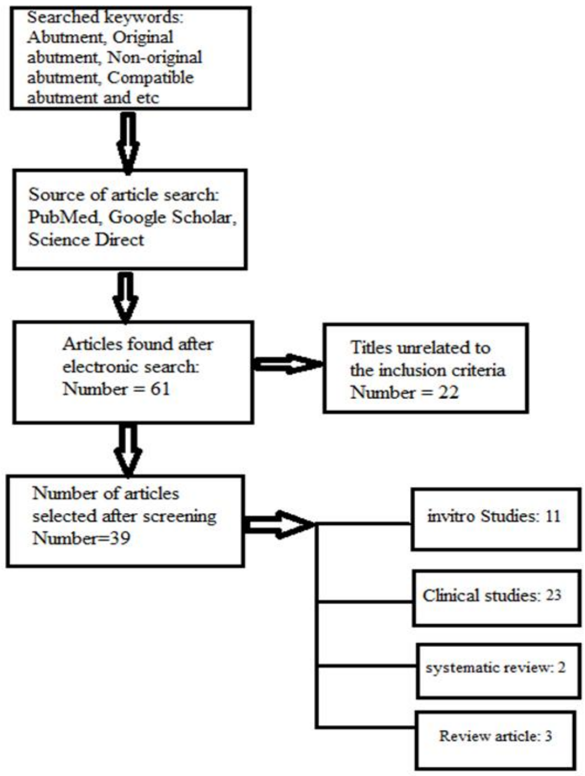


Figure 5. Flowchart of how to review and select articles

Data were collected for the following parameters: fit accuracy, microleakage, bacterial leakage, micromotion, rotational misalignment, screw loosening, fracture resistance, fatigue resistance, tensile strength, marginal accuracy, mechanical results, etc. [28]
In this study, no intervention was done, and only the characteristics of OAs and NOAs were compared.

Results

Comparison of OAs and NOAs in terms of strength

According to the results, OAs have the best fit and the highest percentage of rigid contact in the internal areas. Moreover, OAs have greater resistance to fatigue and the highest long-term stability. Therefore, when OAs are used, the occlusal loads are homogeneously transferred through the system. This leads to increased fatigue resistance, because of the better fit between the internal components [12]. In addition, OA components have the highest percentage of solid contact surface with the implant in the three implant-abutment interfaces. Furthermore, OAs have the highest strength against fatigue compared to NOAs so OA components provide better fitness and mechanical results under cyclic loading than non-original configurations. Additionally, OAs show a lower percentage of torque reduction after cyclic loading than NOAs [12]. Ožiūnas et al. compared original and compatible titanium abutments in terms of screw loosening and 3D crown displacement following cyclic loading analysis and found that original group titanium abutments have lower RTV losses after loading than other groups [30]. Several authors concluded that OAs provide lower values for screw loosening than NOAs [26, 28, 31, 32]

Comparison of OAs and NOAs in terms of bacterial leakage and micro-gap

Previous studies have found significant variations in a mean micro-gap at the implant-abutment interface, bacterial leakage, and rotational misalignment between OA groups and other non-original brands [4, 15, 20]. Meanwhile, Duraisamy et al. found that the average micro-gap in the implant-abutment interface in the external, middle, and internal points are 1.597, 1.399 and 1.831 μm for the OA group and 2.395, 2.488 and 3.339 μm, respectively for NOAs, which indicates a high average micro-gap in NOAs [20]. Although NOAs showed a higher prevalence of infection, the role of the prosthetic abutment manufacturing method on successful implant-prosthetic treatment respecting microbial leakage has not been proven. Therefore, understanding the pathogenesis of peri-implant diseases, the method of manufacturing prosthetic abutments, and the biomechanical role of IAC in achieving successful clinical results in implant-prosthetic treatment is of great importance [25]

Comparison of OAs and NOAs in terms of micro movements and dynamic conditions

The results of previous research show that compatible abutments lead to significant micro movement compared to OAs. These micro movements when accompanied by leakage lead to bone loss around the implant neck and later lead to peri-implantitis [19]. Moreover, OAs are significantly superior to non-original approved abutments in dynamic conditions, although statistically significant differences in static load behavior have not been observed [28].

Comparison of OAs and NOAs in terms of marginal accuracy, micro leakage, etc

Bruno et al. analyzed and compared the mechanical properties of four different types of commercial abutment materials for implant-supported restorations. These materials included: lithium disilicate (A), translucent zirconia (B), fiber-reinforced polymethyl methacrylate (PMMA) (C), and ceramic-reinforced polyether ether ketone (PEEK) (D). Tests were carried out under combined bending–compression conditions, which involved applying a compressive force tilted with respect to the abutment axis. Static and fatigue tests were performed on two different geometries for each material, and the results were analyzed according to ISO standard 14801:2016. Monotonic loads were applied to measure static strength, whereas alternating loads with a frequency of 10 Hz and a runout of 5 × 106 cycles were applied for fatigue life estimation, corresponding to five years of clinical service. Fatigue tests were carried out with a load ratio of 0.1 and at least four load levels for each material, and the peak value of the load levels was reduced accordingly in subsequent levels. The results showed that the static and fatigue strengths of Type A and Type B materials were better than those of Type C and Type D. Moreover, the fiber-reinforced polymer material, Type C, showed marked material–geometry coupling. The study revealed that the final properties of the restoration depended on manufacturing techniques and the operator's experience [33]. In another study, researchers evaluated the internal fit and cyclic fatigue life of three implant-abutment configurations after artificial aging. These configurations included one original abutment and two compatible non-original cast-to-gold abutments.

Forty-eight internal hexagonal joint primary implants were connected to 3 different brands of abutments (n=16): 1 primary to implant system and 2 to non-primary abutments. The internal fit and percentage of the surface with tight contact were evaluated with a scanning electron microscope in 12 cross-sectional samples (4 people) in 3 different areas (platform, internal and screw). Thirty-six implant-abutment-crown specimens (n=12) were immersed in artificial saliva and thermos-cycled for 10,000 cycles between 5°C and 55°C. Subsequently, a cyclic load test, according to International Organization for Standardization (ISO) 14 801, was completed on a universal testing machine at 2 Hz in air. Primary abutments show the best fit and the highest percentage of rigid contact in the inner regions. In addition, primary abutments showed lower cyclic fatigue strength reduction and the highest long-term success [12].

Kim et al. evaluated microleakage at 2 different implant-healing abutment interfaces. This study aimed to evaluate implants from different manufacturers and determine whether the implant-healing abutment interface has a significant effect on implant seal. An air-injection pressure measurement test was performed on implants with either line-contact (modified TSIII [TSM] and Bone Level Tapered [BLT]) or partial face-contact (BlueDiamond [BD], SuperLine [SL], ISII, and UFII) interface design from 6 different manufacturers. Forty implants per implant type were analyzed. BLT implants leaked when the mean pressure was increased to 199.9 kPa. The following implants showed mean leakage pressures of 182.9 (TSM), 157.4 (BD), 112.9 (SL), 101.8 (ISII), and 30.6 (UFII). There was a significant difference between line-contact and partial face-contact implants ($P < .001$) [34]. Another study found a weighted mean incidence of microleakage events of 47% (95% CI: [0.33, 0.60]), indicating that contamination was observed in nearly half of the samples. Regarding the possible factors that may affect microleakage (for example, loading conditions, assessment method, implant-abutment connection design, types of abutment materials, use of sealing agents), loading conditions ($p=0.016$) were the only variable. was that it significantly affected the IME in the case [35].

In general, in most of the included studies, OAs were superior to compatible abutments in terms of marginal accuracy, mechanical results, and micro leakage [4]. In a study, to evaluate the dynamic fatigue performance of implant-abutment assemblies with different tightening torque values, thirty implant-abutment assemblies (Zimmer Dental, Carlsbad, CA, USA) were randomly placed into three tightening groups (n=10) (24 Ncm; 30 Ncm; 36 Ncm). Five samples from each group were opened and their reverse torque values were recorded. The remaining samples were subjected to a load between 30 N~300 N at a loading frequency of 15 Hz for 5 x 10(6) cycles. After the fatigue test, the residual inverse torque values were recorded, if any. In the 24 Ncm stiffening group, all implants fractured at the first external thread of the implant after fatigue loading, with fatigue crack propagation on the fractured surface shown by SEM observation. For the 30 and 36 nm stiffening groups, a statistically significant difference ($p<0.05$) was revealed between the unloaded and loaded groups. Compared with the unloaded samples, the samples were subjected to fatigue loading and the reverse torque values were reduced. Inadequate torque was shown to result in poor fatigue performance of dental implant-abutment assemblies, and abutment screws should be tightened to the torque recommended by the manufacturer. It was also concluded that fatigue loading leads to loss of preload [36].

On the other hand, the external and internal fit of the implant components when using OAs was better than compatible and NOAs [19]. Furthermore, NOAs differed in the design of connection surfaces and materials and showed higher rotational misalignment, which may lead to unexpected failure modes [13]. Overall, the OAs are more accurate than the non-original and compatible abutments. OAs have greater ability in terms of micro leakage resistance, prevention of rotational misalignment and micromovement, and fatigue strength than NOAs as well [27].

Patient satisfaction and survival rate

Evaluation of the clinical results of customized zirconia abutments for single-tooth restorations with implants up to 5 years after placement showed that zirconia abutments performed well during the follow-up period. The rate of technical and biological complications was low and the patients were generally satisfied with the restorations. Therefore, it seems that zirconia abutments for single implant veneers show good short-term technical and biological results [37].

A review of previous studies showed that no significant differences was detected among titanium (Ti), zirconia (Zr), gold (Au), and alumina (Al) abutments in terms of survival rate (excluding Al < Ti ($P < 0.05$), marginal bone loss (excluding Zr < Ti ($P < 0.05$) and Au > Zr ($P < 0.05$)), or discoloration of peri-implant soft tissue. Additionally, Ti abutment had the highest cumulative ranking of survival rate (97.9%); Al abutment had the lowest marginal bone loss (81.4%) and Zr abutment had the least discoloration of peri-implant soft tissue (84.8%) [38].

Discussion

The importance of OAs is determined when even the height of the abutment and the side of the abutment do not affect marginal bone loss or bone regeneration [36], while the use of NOAs can lead to bone loss [18]. During the selection of NOAs, the design of the abutment joint must be carefully adapted to the implant system [20]. Discrepancies greater than 10 μm have been reported to result in bacterial penetration [39]. For example, Karl et al. concluded that both OAs and NOAs show bacterial leakage, with OAs showing less leakage compared to NOAs [15]. The results of all the studies reviewed in this research indicate the high success of OAs compared to compatible abutments. OAs show a lower percentage of torque reduction as well [26]. According to the results of Silva et al., original and non-original screws have the same resistance to failure, but the broken location of screws was different in original and non-original brands [14]. As a result, the loosening or fracture of the prosthesis screw is related to the mismatch between the implant and the prosthesis interface, and the presence of a gap between the implant and the prosthesis interface can cause an unfavorable distribution of stress in the connecting components, implant, and bone. Additionally, the gap between the implant and the prosthesis interface has a significant effect on these findings [40]. Many authors report that screw loosening is one of the most common complications of the prosthesis in implant rehabilitation and may be related to the tightening technique or insufficient torque when tightening. Some authors have reported that the higher the torque and the higher the preload, the less likely the screw is to loosen and thus the prosthesis interface to detach [41]. OAs have an entire internal connection, which allows for a more homogeneous load distribution between the components, ultimately affecting the long-term success of the restorations [10, 13, 28]. The use of OAs for implants results in a more homogeneous load distribution between components, which can impact the long-term success of restorations [12].

While NOAs may look similar to OAs, they show significant differences and variations in their physical and mechanical properties that advanced testing methods can detect. The extent to which these differences affect the reliability and longevity of the clinical performance of the restoration should be investigated in clinical studies.

Although the findings of this research highlight the superiority of OAs, these results cannot be generalized to all patients. The high cost of original abutments makes them unaffordable for many individuals. Therefore, the use of NOAs is recommended as a more cost-effective alternative. It is suggested to conduct studies on the long-term clinical results of OAs versus NOAs. The findings of this study indicate that OAs have lower mechanical failure rates and higher marginal accuracy. While most studies recommend OAs based on these advantages, results also show that in some cases, NOAs are comparable to OAs in fit accuracy and result in fewer mechanical failures [11, 31, 39, 40]. Additionally, OAs are more functionally predictable than NOAs [28]. Therefore, the current clinical recommendation is to use OAs in comparison with NOAs.

Although most of the studies conducted are in favor of OAs, NOAs have also shown acceptable capabilities. For example, compatible abutments are popular because they are more cost-effective. CAD/CAM abutments allow customization of abutment parameters according to soft tissue, increasing fracture toughness, failure mode prediction, no change in fracture toughness over time, reduction of prosthetic steps, and reduction of implant prosthesis functional score and pain reduction [42]. Among custom CAD/CAM abutments, zirconia abutments are more popular due to their favorable mechanical and esthetic properties [43]. In addition, custom CAD/CAM abutments can create more esthetic and natural-looking prostheses in the gingival area. Connection stability is also not significantly different from prefabricated abutments in CAD/CAM abutments due to friction at the abutment-implant interface [24]. Likewise, customized abutments, which are part of NOAs, are used in conditions such as high angle and height of the abutment and provide the possibility of better alignment with angled implants. Also, immediate implantation with a custom-made temporary composite abutment reduces the risk of microbial contamination in the area of bone formation, minimizes soft tissue ischemia, and accelerates the processes of gingival mucosa and bone integration around the implant [44].

More *in vitro* studies are recommended to compare NOAs and OAs on different implant connections. Additionally, long-term studies are needed to monitor the performance of OAs and NOAs. Furthermore, long-term randomized controlled trials should be conducted to provide definitive clinical conclusions about the long-term outcomes of original and compatible abutments. This is important because many existing studies were conducted under *in vitro* conditions, and the observed results may not accurately reflect clinical behavior.

Research indicates that while NOAs can sometimes provide acceptable compatibility with dental implants, they generally exhibit inferior performance compared to OAs. A systematic review highlighted that OAs tend to have better precision of fit, resistance to microleakage, and overall mechanical strength. Specifically, OAs showed superior fatigue strength and reduced micromotion and rotational misfit compared to NOAs. However, some studies suggest that certain NOAs, particularly those designed for external connections, can achieve a precision of fit comparable to that of OAs. This compatibility may result from the design characteristics of external connections, which provide increased rotational freedom and help mitigate misfit issues.

The mechanical properties of NOAs can vary significantly based on their design and manufacturing processes. Discrepancies greater than 10 microns between the abutment and implant can lead to complications such as screw loosening, which is a common issue in implant dentistry. *In vitro* studies have shown that while NOAs may have higher rotational misfit and different failure modes compared to OAs, they can still be clinically viable under certain conditions, especially when used with compatible implant systems [20, 13].

The choice between OAs and NOAs should be guided by clinical considerations, including the specific implant system used, the mechanical demands of the restoration, and the potential risks associated with using NOAs. Although NOAs can offer cost-effective solutions, their long-term performance and reliability may not match that of OAs, necessitating further research and clinical evaluation to better understand their implications in dental implantology [20, 28].

In conclusion, while NOAs can serve as viable alternatives in certain contexts, careful consideration of their compatibility and performance relative to OAs is essential for successful dental implant outcomes.

NOAs can be a more affordable alternative to OAs, especially when OAs are not readily available or are expensive. Also, this cost-effectiveness makes implant treatment more accessible to patients. The availability of NOAs provides clinicians with more options to choose from when OAs are not suitable or accessible. Clinicians can select NOAs that are compatible with the implant system being used.

Conclusion

OAs showed better precision of fit, ability to resist microleakage, prevention of rotational misfit and micromotion, and fatigue strength compared with NOAs. Some NOAs on external connections were comparable with OAs in terms of precision of fit and resistance to screw loosening and may be associated with less catastrophic failures than those on internal connections. OAs present more predictable outcomes than NOAs with regards to the parameters investigated. While OAs may have superior performance, compatible abutments might offer sufficient performance at a lower cost in certain situations.

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