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Peri-implant Soft Tissue Response to Direct Zirconia-Based Composite Customized Healing Abutment: A Randomized Controlled Clinical study with Biochemical Analysis

Thesis Protocol
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I-Abstract

Statement of problem: Light-cured direct zirconia-based composite has many potential uses in dentistry, because of mechanical and biological reasons maintaining the health of peri-implant soft tissues during healing. Direct zirconia-based composite customized healing abutments have superior properties such as biocompatibility, chemical stability, antibacterial and mechanical properties.

Aim of the study: This study will be carried out to compare zirconia-based composite customized healing abutments vs conventional composite customized healing abutment placed simultaneously with delayed dental implant placement.

Materials and Methods: This will be done by clinical evaluation of peri-implant soft tissue changes. Moreover, peri-implant sulcus fluid (PISF) will be measured for the level of Interleukin-1 beta (IL-1β) in the gingival crevicular fluid.

II. Background

In the field of dental implantology, healing abutments play a critical role in peri-implant tissue healing and are traditionally designed as prefabricated components, typically made of titanium.

These abutments have been effective but are limited by their cylindrical shape, which may not mimic natural soft tissue profiles, leading to less favorable aesthetic and functional outcomes.

To address these limitations, the use of customized healing abutments as a treatment strategy, was potentially able to give better results in terms of both soft and hard tissues ***(Almadani et al., 2023).***

Customized healing abutments can be fabricated by advanced materials like PEEK, PMMA, zirconia, resin composite, and titanium have been explored ***(Chokaree et al., 2022).***

Composite materials with nano-zirconium fillers are gaining attention for their ability to combine both biological and mechanical advantages ***(Hu et al., 2019).***

Nano-zirconium fillers, embedded within the resin composite matrix, enhance the material's strength, durability, and wear resistance while maintaining its biocompatibility and chemical stability ***(Bannunah, 2023).***

Long-term randomized clinical controls have shown excellent soft tissue texture, quality and health when zirconia is used subgingivally and supragingivally and shows a qualitatively improved level of interaction between oral tissues and ceramic dental components made from ZrO_2 ***(Kunrath et al., 2021).***

Additionally, these nano-zirconium filler-based composites offer improved aesthetic outcomes due to their tooth-like translucency, making them ideal for anterior regions where appearance is critical.

From a biological perspective, compared to TiO_2 particles, ZrO_2 particles caused reduced toxicity and inflammatory cytokine production ***(Ramenzoni et al., 2021).***

Monitoring inflammatory markers like interleukin-1 beta (IL-1β) can provide valuable insights into the peri-implant tissue response and help compare the performance of these novel materials to traditional titanium healing abutments ***(Khatri et al., 2022).***

Understanding the comparative benefits of these materials could inform clinical decisions and improve patient outcomes in dental implant therapies could inform clinical decisions and improve patient outcomes in dental implant therapies.

II-Research Question

"Do direct zirconia-based composite customized healing abutments have a favorable effect on peri implant soft tissue that may be related to the superior biological properties of zirconium nano particles regarding increased biocompatibility and decreased inflammatory response?"

PICOTS Elements:

Patient/Problem	Patients that are eligible for implant placement within inclusion criteria.
Intervention	Zirconia-based composite customized healing abutment.
Comparator	Conventional composite customized healing abutment.
Outcome	Clinical evaluation of peri-implant soft tissue changes via pink esthetic score and papilla index. Biochemical assessment of IL-1β level in the gingival crevicular fluid using Periopaper strip.
Time	Baseline, 1,2 and 3 months after implantation.
Setting	Faculty of Dentistry, Ain Shams University.

IV.Aim of the study

This study will be carried out to compare between direct zirconia-based composite customized healing abutments vs conventional composite customized healing abutments placed simultaneously with delayed dental implant placement.

Primary outcome:

Clinical evaluation of Pink Esthetic Score (PES) and Papilla Index.

Secondary outcome:

Determine the impact of the customized healing abutment on the level of Interleukin-1 beta (IL-1β) in the gingival crevicular fluid.

Clinical Relevance:

The result will affect the gold standard in choosing the customized healing abutment material for implant patients, regarding which one offers better peri-implant soft tissue results, healing stimulation, and less inflammatory response.

- **Hypothesis:**

Direct zirconia-based composite customized healing abutments do not have a significantly different effect on peri-implant soft tissue compared to conventional composite customized healing abutment in terms of biological properties or biocompatibility or inflammatory response.

VI.Ethical consideration

•**Risk and discomfort of patients**: This research will be conducted with consideration of patient safety and with attempts to reduce discomfort to patient, risks include postoperative pain, edema that can be controlled with medication.

•**Minimization of the risk:** Patient baseline vitals will be taken before any medical procedure to ensure patients safety. Moreover, all medical operation will be conduct under standardized infection control procedure.

•**Criteria for Discontinuation of Study/patient:** patient will be allowed to leave study if developed any complications either related to the study intervention or related to the general condition of the patient. The patient will have the right to withdraw from the study at any time.

•**Benefits to the Patients and to the Community**: patients will receive an aesthetically and functionally implant with no cost. The community will benefit from this study by having a wider range of healing abutments to choose from.

•**Privacy:** All patients identification including patient data and pictures will be locked and not shared.

•**Confidentiality:** patient's data will be treated with utmost confidentiality. In which no personal other than the researchers will be able to view the patient's data.

•**Data Management:** All patient's data will be saved on researcher's personal laptop that are not connected to any intranet connections and no copies will be made in any kind of database.

•**Consent Procedures if Applicable**: any medical procedures and photographs will have a printed written consent form.

•**Patient Informed Consent Form:** a proper consent form will be formulated &signed by the patient before starting any procedure.

VII. Study Design:

Randomized, controlled, parallel design, two arms clinical trial.

VII. Materials and Methods:

- **Study Setting:** Faculty of Dentistry, Ain Shams University.

- **Sample Size Calculation:** A power analysis was designed to have adequate power to apply a two-sided statistical test of the null hypothesis that there is no difference would be found between different tested groups regarding pink esthetic score. By adopting alpha (α) and beta (β) levels of (0.05) (i.e. power=95%) and an effect size (d) of (1.87) calculated based on the results of a previous study[1]; the total required sample size (n) was found to be (18) cases (i.e., 9 cases per group). Sample size was increased to account for possible dropout during different follow up intervals to be (22) cases (i.e., 11 cases per group). Sample size calculation was performed using R statistical analysis software version 4.3.2 for Windows.

- **Eligibility criteria:**

  Inclusion Criteria:

  1.Patients should be systematically free from any disease as according to Cornell Medical Index-Health Questionnaire ***(Pendleton et al., 2004).***

  2.Both genders.

  3.Age from 20-50 years.

  4.Missing tooth to be restored with standard implant, with no need for additional bone and soft tissue augmentation procedures ***(Beretta et al., 2019).***

  5.Implants primary stability ISQ ≥ 70 unites using the Osstell Mentor ***(Baltayan et al., 2016).***

  6.Sound Mesial and distal neighboring teeth.

  7.At least 6 natural teeth remaining in the same arch .

  8.Mouth opening ≥ 30mm.

  9.Thick phenotype.

Exclusion Criteria:

1)Poor oral hygiene condition.

2)Pregnant and lactating females.

3)Smokers.

4)Vulnerable groups (Prisoners and handicaps).

Justification for Exclusions:

To reduce any confounding factors and biases that may affect the results of this study.

Study procedures:

1- **Randomization and allocation concealment technique**: Patients will be randomly allocated according to predetermined computer-generated randomization using www.Randomizer.org

2- **Details of the interventions, testing and follow up:**

- Group I (Customized Zirconia-Based Composite Healing Abutment):
  11 patients will receive delayed implant and a customized zirconia-based composite healing abutment placed simultaneously with implant surgery.

- Group II (Customized Conventional Composite Healing Abutment):
  11 patients will receive delayed implant and a customized conventional composite healing abutment placed simultaneously with implant surgery.

Study protocol and surgical steps:

This protocol will be reviewed by the Research Ethical Committee at Faculty of Dentistry,Ain Shams University.

A) Presurgical procedures:

1)Detailed clinical examination, full history, and radiographic examination (CBCT) will be performed initially to aid in patients' selection.

2)After enrollment, all participants will sign the informed consent.

3)All participants will be subjected to periodontal phase I treatment including periodontal supra- and sub-gingival debridement and oral hygiene instructions.

B) Surgical procedures:

1)After local anesthesia administration, flap is raised, osteotomy site preparation, and implant will be placed.

2)Check the ISQ to exceed or equal 70 unit.

3)A customized Light-cured Direct Zirconia-Based Composite or A customized Light-cured Direct Convential Composite Healing Abutment will be placed.

Assessment:

- Clinical assessment.
- Biochemical assessment.

Clinical Parameters Included:

1-Clinical evaluation of soft tissue:

Pink Esthetic Score (PES) and The Papilla Index will be evaluated and changes between the two groups will be compared at baseline, 1,2 and 3 months ***(Almadani et al., 2023)*.**

Pink esthetic Score :

Variables	0	1	2
Papilla – M	Missing	Incomplete	Complete
Papilla – D	Missing	Incomplete	Complete
Tissue contours	Unnatural	Virtually natural	Natural
Gingival level	>2 mm	1—2 mm	<1 mm
Alveolar process	Clearly resorbed	Slightly resorbed	No difference
Coloring	Clear difference	Slight difference	No difference
Soft tissue texture	Clear difference	Slight difference	No difference

Papilla index :

Description	Variables
No papilla	0
Less than half of the height	1
Half or more of the height	2
Papilla fills entire proximal space	3
Papilla is hyperplastic	4

2-Peri-implant sulcular fluid samples:

Peri-implant sulcular fluid sampling will be performed at the dental implant sites after 2 months of implant placement ***(Lashkarizadeh et al., 2022).***

Using standardized Periopaper paper strips. Paper strips will be placed at the entrance of the peri-implant sulcus and will be inserted to a standardized depth of 1 mm at each site regardless of the PD. In order not to affect the actual fluid volume, sampling time will also standardize as 30 s. Samples with evidence of gingival bleeding were not included. The PISF samples will then be placed in sterile, wrapped Eppendorf tubes and stored until the day of laboratory analysis ***(Tözüm et al., 2007).***

3- Blinding techniques: Single blinding (The data analysts are unaware of the treatment the participant receives).

IX. Statistical Analysis:

Statistical methods:

Categorical data will be represented as frequency (n) and percentage (%) and will be analyzed using chi square test. Numerical data will be explored for normality by checking the data distribution, calculating the mean and median values and using Shapiro-Wilk tests. If the data is found to be normally distributed, it will be presented as mean and standard deviation values and independent t-test will be used for the analysis. If the assumption of normality is found to be violated; the data will be presented as median and range values and will be analyzed using Mann-Whitney U test. The significance level will be set at $p<0.05$ for all tests. Statistical analysis will be performed with R statistical analysis software version 4.3.2 for Windows.

X. Funding of the Study:

This study will be personally funded by the researcher.

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