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Enhancing Immediate Implant Success

The Role of Bone Substitutes and Local Antibiotics in Fresh Extraction Sites

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Abstract

Objective: This study evaluated the effectiveness of bone substitutes and local antibiotics in enhancing osseointegration during immediate implantation in fresh extraction sockets. **Material and Methods**: A total of 30 patients underwent immediate implant placement, divided into three groups: control group receiving no adjuncts, group treated with bone substitutes, and group treated with bone substitutes combined with antibiotics. After four months, success rates were assessed through implant stability quotient (ISQ) measurements. **Results**: The current findings indicated significantly higher success rates in the groups receiving adjunct treatments than in the control, highlighting the potential of bone substitutes and antibiotics in promoting favorable outcomes. **Conclusion**: This study underscores the importance of personalized treatment approaches that consider patient-specific factors and the use of adjunctive therapies to optimize implant success.

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Introduction

Immediate implantation after tooth extraction has gained popularity and recognition in modern dentistry. This shift is driven by possible benefits, including shorter treatment time, preservation of alveolar bone structure, and increased patient satisfaction [1,2]. However, rapid implant placement faces obstacles, such as decreased bone density and quality, and the possibility of postoperative infections, which may prevent favorable outcomes [3]. Researchers and physicians have looked into various complementary strategies to overcome these issues and improve the success of immediate implantation operations. Among these, the use of bone substitutes and local antibiotics have emerged as promising techniques for promoting osseointegration while reducing infection risk [4,5]. Bone alternatives, which include materials ranging from synthetic grafts to xenografts, are critical in maintaining alveolar ridge dimensions and providing a platform for new bone growth [6]. Similarly, the supplementary use of local antibiotics such as chlorhexidine and minocycline has been encouraged to avoid bacterial colonization and infections at the implant site, hence enhancing overall success rates [7,8]. Despite increasing evidence supporting the efficacy of bone replacements and local antibiotics, more research is needed. This involves choosing appropriate biomaterials, antimicrobial agents, and surgical procedures to improve results and prevent complications [9,10]. Furthermore, taking patient-specific aspects into account, such as overall health and anatomical concerns, is critical for personalizing treatment techniques after immediate implantation. Also, the risk of necrosis of the bone is reduced due to the decreased surgical trauma. Moreover, the natural socket rich in periodontal cells and matrix makes healing faster and more predictable [11].

The current *in vivo* study seeks to critically assess the effect of bone substitutes and local antibiotics in improving the success rate of immediate implantation in fresh extraction sites and to clarify the effectiveness, safety, and therapeutic consequences of various adjunctive therapies by combining current literature and empirical evidence. Furthermore, it intends to give evidence-based recommendations to optimize treatment methods and increase patient outcomes during immediate implantation in fresh extraction sites.

Material and Methods

A total of 30 male patients, with a mean age of 35 years (range 25-45 years) were included in this study. All selected patients had three or more unrestorable hopeless

premolar teeth indicated for extraction in the lower arch. Ninety Neodent implants (Grafelfing, Germany) were used in all patients, and three implants were implanted in each patient.

Each patient who signed an informed consent form was fully educated about the immediate implantation procedures and all the risks involved with this kind of surgery.

Grouping of samples

The patients were divided into 3 study groups (n=30) according to the following protocol used:

Group A (Control): Every patient in this group immediately had one tapered implant in the freshly extracted sockets

Group B: Every patient in this group immediately received one implant in the freshly extracted sockets. After implantation, a bone substitute (Bioplast-Dent) was added to the gap between the implant and socket wall.

Group C: Every patient in this group immediately had one implant in the freshly extracted sockets. After implantation, a bone substitute mixed with an antibiotic (lincocin) was added to the gap between the implant and socket wall.

Inclusion criteria

1. Patient with good health status.

2. Patient should be between 25-45

3. Reasons for initial tooth extraction (trauma, caries, root resorption, and endodontic failure).

4. Presence of adequate gingival architecture with surrounding dentition.

5. Good oral hygiene.

6. Adequate bone volume.

7. Root fracture either vertical/horizontal

8. Teeth which are periodontally involved

9. Chronic periapical/ periodontal infection

Exclusion criteria

1. Poor oral hygiene.

2. Chronic or acute systematic disorders (uncontrolled diabetes, hemorrhagic diathesis, general or auto immunodeficiency).

3. Poor interest or cooperation from the patient.

4. Existence of non-treated generalized periodontitis.

5. Insufficient bone volume at the receptor site.

6. Pathological changes at the receptor site (cysts, tumors, osteomyelitis

7. Patient still growing (child or adolescent).

8. Medically allergic and compromised patients.

9. Presence of dehiscence or fenestrations.

10. Heavy smokers, alcohol or drug abusers.

11. Acute periapical/periodontal infections

12. Proximity to vital anatomic structures

Implant size selection

Radiographic evaluation

Bone evaluation at the implant placement site was performed, along with the estimation of tooth size to be removed (root length and root width at the CEJ) and the closeness of the implant site to important anatomical structures using OPG, IOPA, and computed tomography scans. The implant size used was determined using these characteristics as a reference. The mandibular cone beam computed tomography (CBCT) was utilized to assess the diameter and length of sockets dimensions. According to the CBCT assessments, the socket diameters were 5.5-7 mm in the crestal direction, 3-4 mm in the apical direction, and 10-13 mm in length. Accordingly, tapered self-tapping implants were selected. The implant diameter in groups B and C was carefully chosen to be 2mm less than the crestal socket width, whereas, in Group A, it was selected to be the same size as the crestal part of the socket. The length of the implants in all groups was chosen to be 1.5 mm below the crestal bone level (Figure 1).

Surgical procedure

Atraumatic teeth extraction

Atraumatic teeth extraction was carried out using periotomes. Teeth were extracted with minimal trauma to the alveolus and rotational movement was used to avoid damaging the buccal plate[12].

Implant insertion

Immediately after tooth extraction, the implants were placed into the sockets without drilling [12-15]. The implants in group A (control) were inserted into the socket without the addition of any bone substitute. In group B the implants were inserted, and the 2mm gap between the implant and socket walls was filled with a bone substitute, however in group C the implants were inserted, and the 2mm gap was filled with bone substitute mixed with the antibiotic.

After implant insertion for the three groups, a slice of absorbable collagen wound dressing Zimmer Collagen Plug (USA) was placed over the implant, then the buccal and lingual gingiva were sutured using a reverse cut needle 0\4 silk.

Second stage surgery

After four months, the implants of all groups were exposed and assessed for osseointegration using resonance frequency analysis (RFA) using an Osstell device (Ab Integration Diagnostics, Gothenburg, Sweden) [16]. It is expressed as an implant stability quotient (ISQ) in units ranging from 1 to 100. Each transducer is calibrated by the manufacturer, which makes all measurements directly comparable [17-20] (Figure 2).

The criteria used to define the success or failure of the implants are as follows:

1- success: ISQ value of 60 or more with no mobility.

2- failure ISQ value less than 60 with mobility

Statistical Analysis

A chi-square test for independence was conducted to compare the success and failure rates among the three implant groups. This test assesses whether significant differences exist in the distribution of success and failure rates among the three groups. Following the chi-square test, pairwise comparisons between the implant groups were performed. These comparisons were conducted using chi-square tests for each pair of groups. The Bonferroni correction was applied to control for the family-wise error rate due to multiple comparisons. The adjusted significance level for each pairwise comparison was set at $\alpha' = 0.05 / 3 \approx 0.0167$.

Results

The frequency of successful and failed implants for each group was [$\chi 2(2, N=90)=11.607$, $p=0.003$]:
Group A: 19 successful implants, 11 failed implants.
Group B: 27 successful implants, 3 failed implants.
Group C: 29 successful implants, 1 failed implant.

Group A vs Group B: $\chi 2(1,N=60)=7.004$, $p=0.008$.
Group A vs Group C: $\chi 2(1,N=60)=9.202$, $p=0.002$.
Group B vs Group C: $\chi 2(1,N=60)=0.352$, $p=0.553$.

Discussion

The current study showed a significant success rate of immediate implantation procedures done in fresh extraction sites in groups B and C compared to control group A. Thus, the null hypothesis regarding using bone substitutes and local antibiotics to enhance Osseo-integration was rejected. Immediate implantation offered a shortened treatment duration and preservation of alveolar bone structure. Both are essential to get the most effective treatment and functional results. However, many challenges such as bone type and post-operative infection can influence the treatment outcome [1,2].

One of the most important factors for the success of osseointegration is implant stability which can be classified into primary (mechanical engagement) and secondary stability (osseointegration) [21]. In the present study, the primary stability was achieved by bone substitutes in groups B and C and by socket walls in group A despite not measuring the primary stability. A previous study [22] assessed the stability of a clinically successful implant employing resonance frequency analysis. After a year of loading, the successfully integrated implant had ISQ values ranging from 57 to 82 ISQ. Results of the present study showed ISQ levels between 60 and 81 ISQ with a mean of 70 ISQ after 4 months of immediate implantation in the mandibular arch. Our results agree with those of Balleri et al. [22], Deng et al. [17], and Harirforoush and Arzanpour [18] who suggested that the strong interface between the implant and bone is observed in high ISQ values. However, Kittur et al. [23] stated that despite the osstel being a non-invasive and widely used equipment to asses implant stability, his review revealed that there is no single universally accepted method to determine secondary implant stability.

The use of bone substitutes in this study could have played a major role in the success rate of group C compared to group A. Therefore, bone substitutes could provide support for implants surgically implanted without drilling. This could reveal that the primary stability achieved for successful osseointegration is supposedly related to bone substitutes. This was consistent with several studies that stated that a bone substitute in the fixture–socket gap preserved socket volume and supported new bone formation [24,25].

The preservation of the bone structure and minimizing soft tissue trauma was achieved in this study by using atraumatic extraction. So, the gap filled by the bone substitute was supported by the alveolar bone and the untraumatized tissue accelerated the healing process and complication.

This was in agreement with Tarnow et al. [26], who stated that atraumatic extraction preserves the integrity of the socket, and the immediate placement of implants into extraction sockets with an intact buccal wall allows healing and osseointegration.

Limitations of the study

Despite the positive results of this study, several limitations need to be considered. The very small sample size and homogeneous patient demographics may restrict the findings' application to wider patient populations. Future research should look into longer follow-ups to verify the instant implantation methods' long-term safety and effectiveness. Additionally, comparative analyses of different antibiotic combinations and bone replacements are required to ascertain the optimal treatment plan based on specific clinical circumstances.

Conclusions

Within the limitation of this study, bone substitutes are a potentially effective way to improve the outcome of immediate implantation treatments after tooth extraction. Combining local antibiotics with bone substitutes is an effective way to prevent infection. Atraumatic extraction as a major factor positively affects the success rate of immediate implantation in fresh extraction socket.

Conflicts of Interest

The authors have no conflicts of interest to declare.

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Author's Contributions

All authors studied conception and design, methodology, statistical analysis and interpretation of results, original draught manuscript preparation, writing, review and editing. All authors reviewed the results and approved the final version of the manuscript to be published.

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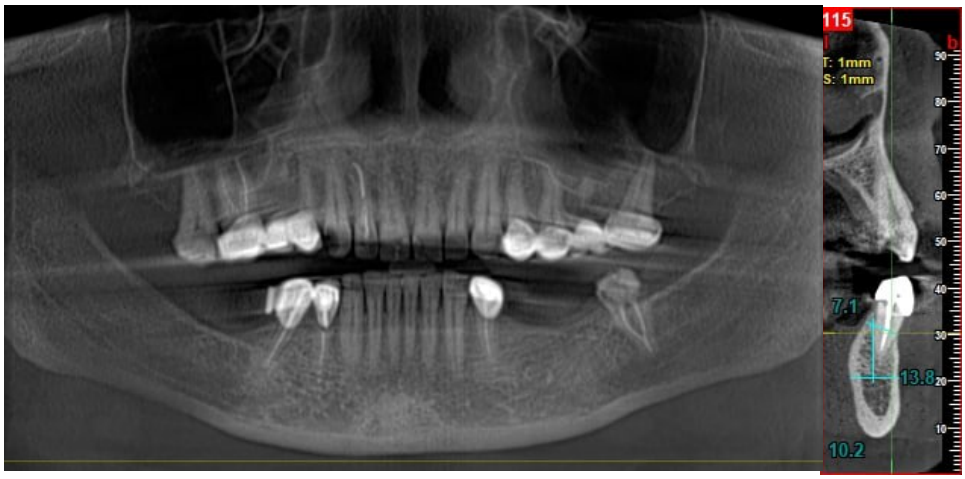

Figure 1. Diameter and length of the socket before extraction.

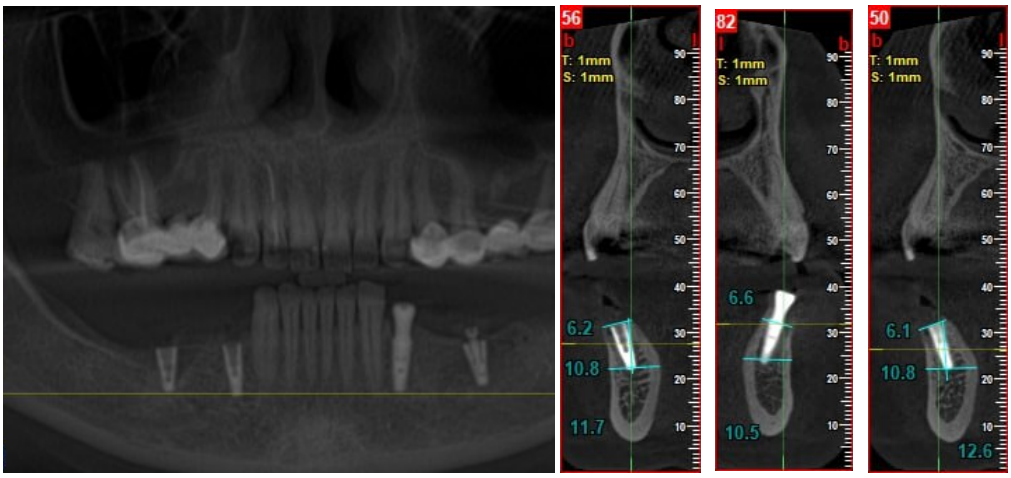

Figure 2. Dental implants 4 months after placement.