# Enhancement of Buccal Bone with Immediate Implant placement in Anterior Maxilla for Maximizing Esthetical Outcome

**Original Article**

*Mohamed A. Elsholkamy [1] , Mina A. Abdelmesseh [2] , Mohammed H. Eid [3]*

*Professor of oral and maxillofacial surgery, Faculty of Dentistry, Suez Canal University. Assistant Lecturer of Oral and Maxillofacial Surgery, Faculty of Dentistry, Sinai University , ***Lecturer of Oral and Maxillofacial Surgery, Faculty of Dentistry, Suez Canal University.*

## ABSTRACT

**Objectives:** The purpose of this study was to evaluate clinically and radiographically the effect of four different materials and techniques on buccal bone preservation during immediate implant placement in order to obtain maximum best esthetical outcome. **Materials and methods:** Forty implant cases were divided randomly into four groups. In group A, an implant with adequate diameter was placed to create a gap between the implant and the buccal wall of the socket, which was then filled with tricalcium phosphate. In Group B, the buccal gap between the implant and buccal wall of socket was filled by Allograft. In Group C, the buccal gap between the implant and buccal wall of socket was filled by L-PRF. In Group D, buccal shield technique was applied by sectioning root into buccal and palatal segments. The palatal segment was removed, while the buccal segment was reduced into thin shield which was then preserved with implant placement to preserve the blood supply from the periodontal attachment. Initial CBCT was taken preoperatively and final CBCT was taken six months after implant placement, from Buccal bone height and width was measured. **Results:** The four groups attained sufficient final stability to support successful prosthetic. LPRF application and buccal shield technique application preserved buccal bone height and width eliminating the expected buccal bone resorption due to the loss of blood supply from the periodontal attachment, while tricalcium phosphate and allograft application increased buccal bone width beside preserving buccal bone height. **Conclusion**: The four groups were successful in preserving buccal bone height and width which improved the final esthetic result with no metal display, while tricalcium phosphate and allograft application were superior in increasing buccal bone width which increased the expected lifespan of the implant

**Key Words:** Dental implant, Tricalcium phosphate, Platelet-rich fibrin, Buccal shield

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**Corresponding Author:** Mina A. Abdelmesseh, assistant Lecturer of Oral and Maxillofacial Surgery, Faculty of Dentistry, Sinai University, Egypt **Tel.:** 01226998022, **E-mail:** mina.abdelmesseh@su.edu.com

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## INTRODUCTION:

AEsthetically speaking, for an implant treatment to be considered successful it must have visually pleasant prosthesis surrounded by healthy peri-implant tissue. The definition of healthy peri-implant tissue expanded not only to include sufficient mucosal thickness (MT) but also to include sufficient peri-implant bone thickness (PBT) leading to the term peri-implant phenotype. Whereas the buccal bone thickness in the anterior region is considered the foundation to support enough mucosal thickness to obtain the maximum esthetical outcome. The need to preserve as much bone as possible lead to the arise of immediate implant technique with its major advantage over the conventional implant technique which is better preservation of bone leading to better soft tissue esthetics. other advantages include easier placement of implant with proper position and lesser number of visits with less treatment time leading to less cost. (Wang et al., 2021)

This points out to the main obstacle facing securing maximum esthetical outcome during immediate implant placement in the anterior region, which is the insufficient buccal bone, as the buccal bone especially in the anterior region is usually thin cortical bone with no cancellous bone support. Deprived from the blood supply supplied by the cancellous bone support, the thin buccal cancellous bone only receives blood supply from the periosteum and the periodontal ligament of the adjacent teeth. During immediate implant placement the blood supply from the periodontal ligament is cut after extraction leading to further decrease in blood supply and further increase in bone resorption. Moreover, most of the teeth which need replacing is either periodontally or apically inflamed leading to further loss of buccal bone.(Meijer et al., 2019)

With the normal bone loss around successful implant about 0.2 mm per year, its essential to start with enough buccal bone bulk to ensure long survival of the implant. One of the main techniques for enhancing buccal bone with immediate implant placement is creating a gap between the implant and the buccal wall of socket by selecting implant diameter 3mm lesser than buccolingual

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dimension of the socket at the crestal level. The gap is then filled with bone grafts to augment the buccal bone by preventing the vertical bone loss and by adding to the thickness of the bone.(Botermans et al., 2021)

Various types of bone grafts including alloplasts, allografts or autografts can be integrated in buccal bone augmentation during immediate implant placement. The main enhancing property of bone grafts is their osteoinductive activity where the act as a scaffold for the osteogenic cells to form new bone. The main advantage of allografts and xenografts over alloplasts is their osteoinductive activity where they can induce cell differentiation into osteogenic cells, while the main advantage of alloplasts is less reactive to the body immune system.(Behnam Bohlouli, 2015)

Since introduced by Choukroun in France at 2000, leucocyte- and platelet-rich fibrin become a revolutionary step since it requires only simple centrifuging without any chemical additives which lead to formation of tetra molecular structure of fibrin matrix containing platelets, cytokines, leucocytes and some stem cells. The fibrin architect allows for longer durability extending to 14 days with gradual release of growth factors over this period. The activated gel form although allow foe better manipulation. (Gkikas et al., 2020)

Another technique for preserving buccal bone includes preserving its blood supply from the periodontal ligament by preserving thin buccal segment of the tooth with its periodontal attachment. The buccal shield technique involves sectioning the root into buccal and palatal segments. The palatal segment is removed, while the buccal segment is reduced into thin shield which is then preserved with implant placement. The preserved periodontal ligament between the buccal shield and the socket wall allows for continuation of blood supply and eliminates bone resorption.(Barakat et al., 2017)

## MATERIALS

***Eligibility criteria:***

The patients were selected according to the following criteria:

***•Inclusion criteria:***

Forty immediate implant cases for replacing single rooted teeth were divided randomly into four equal groups.

Group A: Tricalcium phosphate

Group B: Allograft

Group C: L-PRF

Group D: Buccal shield technique

***•Exclusion criteria:***

Patients with physical status classified as ASA class III, class IV and class V. Teeth with acute or chronic infection or with lost buccal plate of bone.

***Preoperative evaluation:***

A- Medical and dental examination sheets were performed for all patients of the study. The sheet included full personal data, chief complain, history of chief complains, medical history, and dental history.

B- Cone beam was done to assess bone density around the tooth, whether there is apical lesion or not and whether there is a buccal fenestration or not.

***L PRF preparation***

10 ml of blood was drawn from the patient's antecubital vein, divided into two tubes (5 ml each) without anticoagulant and immediately centrifuged at 3000 RPM for 10 minutes to obtain three layers; upper layer consisting of acellular Plasma, middle layer consisting of PRF clot, and lower layer consisting of red blood cells. The middle layer which consisted of a fibrin mesh trapping high content of platelets was obtained separating it from the lower layer 2mm below the junction between the two layers (Fig. 1).(Pavlovic et al., 2021)

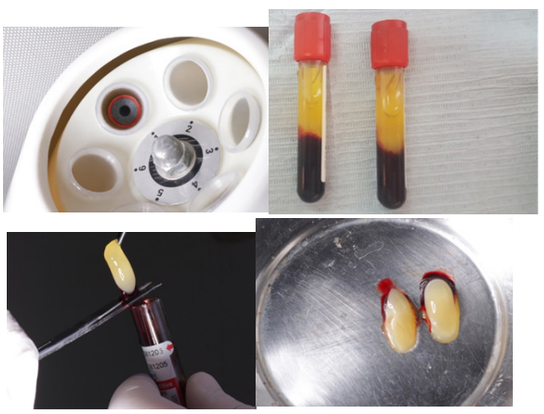


**Figure. 1**: A Clinical photograph showing the L-PRF preparation

***Surgical protocol:***

For group (A): The tooth was extracted with minimum trauma using periotome. The osteotomy for the implant was done and the implant was placed allowing for 3mm gap between the implant and the buccal bone, which is then filled with Tricalcium phosphate. A healing cap was placed over the implant and the patients were followed on postoperative instructions and Antibiotics were subscribed for 5 days

For group (B): The surgical procedures were essentially the same as group A until compilation of osteotomy after which allograft was inserted inside the gap between the implant and the buccal socket wall. The rest of the essential procedures were followed.

***For group (C)***: The surgical procedures were essentially the same as group A until compilation of osteotomy after which L-PRF was inserted inside the gap between the implant and the buccal socket wall. The rest of the essential procedures were followed (Fig. 2).

***For group (D):*** The remaining root is sectioned into buccal and palatal segments. The palatal segment is removed, while the buccal segment is reduced into thin shield and preserved. The rest of surgical procedure including osteotomy and implant placement is then followed (Fig. 3).

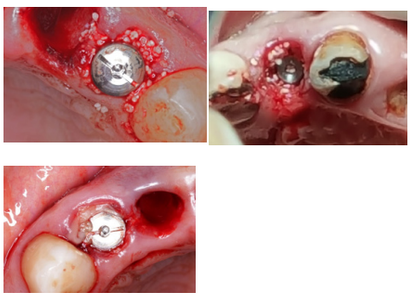


**Figure. 2:** Clinical photographs showing filling the buccal gap with Tricalcium phosphate, allograft and L-PRF respectively.

**Figure. 3:** Clinical photographs showing the Buccal shield technique procedures.

***Postoperative evaluation:***

CBCT was taken preoperatively and final CBCT was taken six months after implant placement.

***1) Buccal bone height measurement:***

The same cut was fixed in both initial and final CBCT in across sectional view with zero thickness. The height of the buccal bone was measured from the buccal bone crest to a fixed anatomical structure in both initial and final CBCT. These fixed anatomical structures in the upper jaw included floor of the nasal cavity and maxillary sinus.

***3) Buccal bone thickness measurement:***

The buccal bone usually ends in a knife-like edge with maximum thickness about 2 to 3 mm below the crest. The maximum thickness of buccal bone in the coronal third of implant (the area where the buccal gap initially exists) was measured in both initial and final CBCT (Fig. 3).

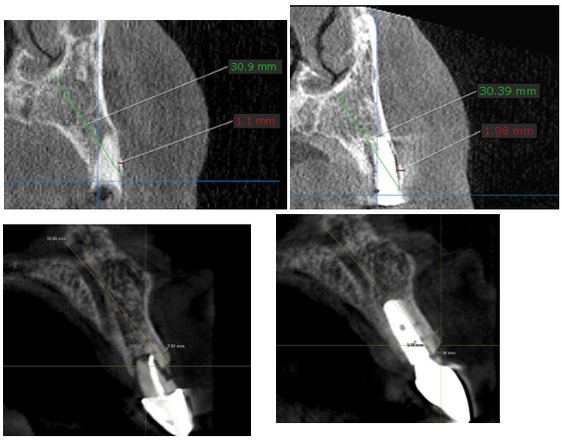



**Figure. 3:** photographs showing cross sectional view with zero thickness for buccal bone height and thickness measurements in preoperative and postoperative CBCT respectively.

## RESULTS:

The study included 19 patients in which 40 immediate implants were placed replacing unrestorable single rooted teeth. From the total 40 implants, 25 were placed in female patients with ratio 62.5% and 15 were placed in male patients with ratio 37.5%, while the total mean age in the whole sample was 43.35.

The 40 implant cases were divided randomly into four groups 10, implant cases each. In Group A, the buccal gap between the implant and buccal wall of socket was filled with tricalcium phosphate. In Group B, the buccal gap between the implant and buccal wall of socket was filled by Allograft. In Group C, the buccal gap between the implant and buccal wall of socket was filled by L-PRF. In Group D, buccal shield technique was applied by sectioning root into buccal and palatal segments with preserving the buccal segment.

***1. Buccal bone height***

The results in table 1, statistical analysis showed no significant difference between groups at initial and at the end of experiment (final) at $P<0.05$.

The high mean values for Buccal bone height at initial and final was recorded in G4, followed by G3, and the lowest value was recorded in G1 and G2.

As regards to changes within each group, there was no statistically significant decrease in buccal bone height for all groups (fig, 1).

**Table (1):** changes in buccal bone height.

Table 1, Buccal bone height

| | Initial | Final | %change | Paired samples T test | P value |
|---|---|---|---|---|---|
| G1 | 26.19±5.65a | 26.12±5.41a | -0.27 | 0.029 | 0.977ns |
| G2 | 26.33±5.41a | 26.29±5.58a | -0.20 | 0.162 | 0.875ns |
| G3 | 29.45±5.65a | 28.91±5.52a | -1.8 | 1.64 | 0.135ns |
| G4 | 29.67±5.65a | 29.42±5.66a | -0.8 | 0.578 | 0.578ns |
| F test | 1.16 | 0.898 | | | |
| P value | 0.336ns | 0.451ns | | | |

ns, means no significant difference at P<0.05

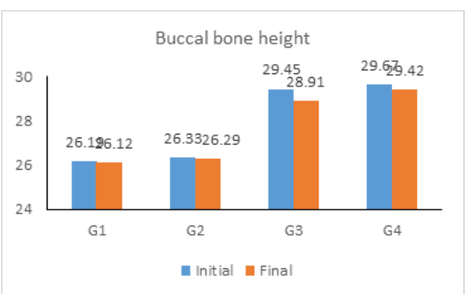



**Figure 1,** Graphical representation showing the changes in buccal bone heigh.

### *2. Buccal bone width*

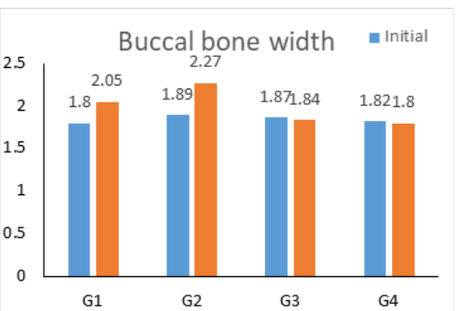
The results in table 2, statistical analysis showed no significant difference between groups at initial and at the end of experiment (final) at P<0.05. The high mean values for Buccal bone width at initial was recorded in G2, followed by G3, and G4 and the lowest value was recorded in G1. While the high value was recorded in G2, G1 and the lowest value was recorded in G4 and G3. The changes for each group were significant increase in G2 (19.9%) and G1 (13.9%) and decreased in G3 and G4 with -1.4% (fig, 2).

**Table (2)**, The changes in buccal bone width.

Table 1, Buccal bone height

| | Initial | Final | %change | Paired samples T test | P value |
|---|---|---|---|---|---|
| G1 | 1.80±0.78a | 2.05±0.77a | 13.9 | 2.589 | 0.027* |
| G2 | 1.89±0.74a | 2.27±0.81a | 19.9 | 4.79 | 0.001* |
| G3 | 1.87±0.58a | 1.84±0.97a | -1.4 | 0.108 | 0.916 |
| G4 | 1.82±0.58a | 1.80±0.97a | -1.4 | 0.11 | 0.943 |
| F test | 0.35 | 0.540 | | | |
| P value | 0.99ns | 0.657ns | | | |

**, means significant difference at P<0.05
Ns, means no significant




## DISCUSSION:

The esthetical outcome of implant treatment in the anterior region has been subject for plenty of studies, comparing between different surgical procedure to optimize the esthetical outcome. Francescato O., Et al. In 2023 studied various surgical approaches to obtain maximum esthetical results with implant treatment in the anterior region. He found tendency to obtain better results when dental implants are placed immediately in flapless surgeries with simultaneous guided bone regeneration treatment at the time of implants installation.(Francescato, 2023)

The current study tested the effect of 4 materials and techniques that can be done during flapless immediate implant placement to enhance the buccal bone for maximizing the esthetical outcome.

The first three groups tested the effect of filling the peri-implant gap with either Tricalcium phosphate, Allograft or L-PRF, while the fourth group tested Buccal shield technique. CBCT was done preoperative and after six months from the implants placement to measure the changes in buccal bone Hight and width. Gröbe A., Et al. In 2017 tested the accuracy of CBCT in bone volume measurement around titanium implants. He concluded that CBCT imaging is a reliable diagnostic tool to determine peri-implant bone loss and therefore estimate the prognosis of implant survival. (Gröbe et al., 2017)

In the current study, the buccal bone height measurements showed non-significant decrease in buccal bone height between preoperative and final CBCT in all groups. These results showed that the four procedures can preserve buccal bone height, leading to better support for the soft tissue which will result in improved final esthetical outcome with o metal display.

In terms of buccal bone width, groups A and B having tricalcium phosphate and allograft placed in the buccal gap showed significant increase in buccal bone width in comparison with groups c and d having L-PRF placed in the buccal gap and Buccal shield technique which showed no change in buccal bone width. However, both L-PRF and buccal shield technique showed evidences of buccal bone preservation with non-significant decrease in both height and width of buccal bone.

The results of current study favored tricalcium phosphate and allograft in terms of buccal bone width increase. The significant increase in buccal bone width with tricalcium phosphate and allograft application might be attributed to the space filling advantage of tricalcium phosphate which prevents collapse of buccal bone towards the implant closing the gap. Moreover, the tricalcium phosphate inside the gap acted as scaffold for osteoplastic cells and growth factors forming new bone between the buccal bone and the implant resulted in buccal bone width increase. Another benefit of the gap filling properties of tricalcium phosphate is the prevention of connective tissue and epithelium migration inside the gap which might interfere with osseointegration process.

Scarano A., Et al. in 2016 investigated the benefits of mineralized bone cortical allograft with immediate implant placement. His final conclusion was that the use of allograft limited the buccal wall bone resorption, moreover the regenerated bone was with the same histological structure as the original bone (Orti et al., 2016)

The results of the current study are in agreement with L. Yusuke, Et al. in 2015, who studied the effect of tricalcium phosphate on preimplant gap. A 5 mm defect was created in the alveolar bone of dogs' mandibles and implant was placed in the distal region of bone defect.

The group of implants in which the preimplant gap was filled by Hydroxyapatite Tricalcium Phosphate was found to induce new bone formation earlier than other group with the entrance of osteoblasts on the filled earlier than other groups in which the gap was left empty.(Ioku et al., 2015)

The results of current study are also in agreement with S. Arora, Et al. in 2019, who tested the effect of PRF on the buccal bone after placing PRF plug inside the gap between the implant and buccal bone and covering the implant with PRF membrane. The results showed that PRF improved regeneration of soft tissue and diminished buccal bone loss resulting in better final esthetic outcome.(Arora et al., 2016)

Scarano A., Et al. in 2023 studied the effect of Socket shield technique om immediate implant procedure. The result showed less bone resorption and more improve esthetical outcome(Scarano et al., 2023)

## CONCLUSIONS

Immediate implant technique is reliable with high success rate and better esthetical outcome over the conventional delayed technique. Tricalcium phosphate and allograft is superior in terms of buccal bone width increase when placed in the preimplant gap while all tested bone augmentation techniques can preserve buccal bone height and width with no metal display or bad esthetics.
Despite the additive superior osteoinductive activity of allografts over the osteoconductive activity of the alloplasts, the present study showed that both are capable of bone formation with equivalent increase in bone size. This might be attributed to the osteoconductive activity of both grafts which is the major factor affecting bone formation by creating a scaffold for new bone cells to grow on its surface.

## CONFLICT OF INTEREST

This clinical study was self-funded by the authors, with no conflict of interest.

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