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Autogenous Tooth Root Versus Autogenous Bone-Block Grafts for Maxillary Lateral Alveolar Ridge Augmentation

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ABSTRACT

Objectives: To compare between autogenous tooth roots (TR) and autogenous bone blocks grafts (AB) for bone gain in maxillary lateral alveolar ridge augmentation

Material and Methods: A total of 14 patients in need of maxillary lateral ridge augmentationfor future implant therapy were allocated to parallel groups receiving either (a) healthy autogenous tooth roots (e.g., retained wisdom or impacted teeth) (n = 7) or (b) cortical autogenous bone blocks harvested from the chin area.

Results: Soft tissue healing was uneventful in both groups. Six months after augmentation patient was evaluated radiographically for bone gain and resulted in higher bone gain in tooth root group than bone group

Conclusions: TR may serve as an alternative graft to support lateral alveolar ridge augmentation and two-stageimplant placement.

I. INTRODUCTION

It is well known that after tooth extraction, the alveolar ridge's buccolingual and apicocoronally dimensions are reduced.[1] Clinically, the horizontal dimension of the alveolar ridge is the most affected. The ability to successfully place dental implants may be affected by inadequate alveolar ridge width (caused by knife-edge configuration or non-space-maintaining defects) [2]

For the successful placement of an implant in a narrow alveolar ridge, horizontal bone augmentation is a critical and necessary treatment. There are many treatment options include guided bone regeneration[3] onlay bone grafting[4] alveolar bone splitting method[5] and distraction osteogenesis.[6]

Various surgical principles were suggested to solve these dynamic deficiencies; distraction osteogenesis, vertical and horizontal bone augmentation, ridge splitting, and guided bone regeneration are commonly used.[7,89–11]It is important to remember that when comparing the various treatment modalities for the prosthetic replacement of lost teeth, the aim is to provide a functional restoration that is in harmony with the adjacent dentition, and to provide cure that will lead to maintain the natural tissue contours in order to prepare for the future implant prosthesis.

Autogenous bone block (ABB) harvested from intraoral donor sites (i.e. retromandibular, or chin) is the most commonly used procedure for lateral alveolar ridge augmentation[12] However, despite significant horizontal bone gains, cortical bone blocks were noted to undergo an incomplete replacement resorption[13,14] thus featuring a composition of non-vital residual and newly formed vital bone in the former defect area[15] Moreover, AB block is prone to a rapid degradation and therefore commonly combined with contour augmentation procedures using slowly resorbing particulate grafts and barrier membranes, in addition to donor site morbidity. [16] Autogenous tooth root graft (ATR) is a new autogenous bone grafting material that is biocompatible, mainly composed of hydroxyapatite with a low crystal structure with physicochemical characteristics similar to that of bone. It contains both minerals as well as organic components and it promotes bone regeneration[17] Recently, extracted tooth roots were used as block autografts for lateral ridge augmentation and it was observed that they supported the staged early osseointegration of titanium implant by basal osseous graft integration at the recipient site followed by gradual graft resorption and replacement by new viable bone[15]

II. MATERIALS AND METHODS

Patient selection:

Fourteen patients who have narrow maxillary alveolar ridge seeking prosthetic rehabilitation were selected from the Out-Patient Clinic of Oral and Maxillofacial Surgery Department, Faculty of Dentistry, Mansoura University.

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A short explanation of the procedure and possible risks that are associated with it were given to the candidates. All patients were provided informed written consent prior to the surgery.

Criteria for patient selection:

- **Inclusion Criteria:**

1. Trauma or pathology-induced severe horizontal alveolar ridge defect in maxilla leading to insufficient bone ridge width.
2. Patients with good oral hygiene.
3. Patients with tooth indicated for extraction.

- **Exclusion criteria:**

1. Patients with systemic diseases that absolutely contraindicate dental implant placement or affect osseointegration e.g. patients that take radiotherapy, chemotherapy, osteoporosis, heart disease, bleeding disorders
2. Patients with parafunctional habits (bruxism and clenching).
3. Heavy smokers (i.e., More than 20 cigarettes/day).

Patients Classification:

Patients were equally allocated into two groups:

- **Control group:** Lateral alveolar ridge augmentation was done using an autogenous bone block graft harvested from mandibular symphysis area.
- **Study group:** Lateral alveolar ridge augmentation was done using an autogenous root block graft prepared from extracted teeth that is indicated for extraction.

Materials:

- **Guided bone regeneration (GBR) kit[1]:**

- Titanium fixation screws: stainless-steel self-tapping fixation screws 7, 9,11 mm in length were choosed according to expansion needed.
- Chisel & mallet.

- **Piezoelectric surgical device2:**

- Piezotomed instruments are preferred over any other instruments as they allow for maximum intraoperative precision and minimal tissue damage.

- Donor tooth = Any patient`s own tooth indicated for extraction.
- Diamond bur.

Preoperative preparation:

- Patients were first screened clinically and radiographically to see whether they comply with the selection criteria. After that, preoperative preparation was done to those who met the criteria.
- Clinical examination and palpation of the entire oral and para-oral tissues to ensure right selection of the patient.

1- Study cast:

Impressions were taken to produce study casts, which were then mounted on simple hinge articulators. Evaluation of the prosthetic options in terms of occlusion, inter-arch space and teeth inclination were done.

2- Intra-oral photographs:

Preoperative intraoral photographs were taken as a baseline record before starting with the treatment plan.

3- Radiographic examination:

Panoramic radiographs were requested for initial assessment then Cone Beam CT scans were taken for further detailed information regarding jaw bones to determine height and width of alveolar ridge.

- **For recipient site:**

The residual ridge width was measured as the distance between buccal and lingual cortical walls

- **For control group:**

a. To detect location of the mandibular canal and mental foramen.

b. To determine width, bone quantity, quality at symphysis area and its relation to adjacent teeth for accurate treatment planning, and identify the neurovascular components, which can affect the surgical design.

- **For study group:**

To assess the donor tooth & the site from where we took it.

4- Preoperative medication:

- Prophylactic antibiotic in the form of 1 gm. tablet of amoxicillin + clavulanic acid[3] were taken, one gram tablet b.i.d. the day before and day of surgery.
- If the patient allergic to penicillin, Levofloxacin 500 mg[4], one tablet per day the day before and after the day of surgery.
- Dexamethasone[5] 8mg ampule was taken I.M in the morning of the day before and day of surgery

Surgical Protocol

All surgical procedures were done under local anesthesia.

[1]Biomaterials Korea, Seoul, Korea.
[2]Woodpecker DTE, DS-II, Guangxi, China.
[3]Augmentin 1gm tablets, GlaxoSmithKline Pharmaceuticals, Egypt.
[4]Larivex, 500mg tablet, Euro-Egy-Pharm, Egypt.
[5]Dexamethasone, 8mg/amp, Amriya, Egypt.

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The recipient site was prepared first to receive the graft either autogenous bone graft or autogenous tooth root block graft. After successful anterior and middle superior alveolar and greater palatine nerve blocks using articaine[6] 4% with 1:100,000 epinephrine, a full thickness incision with three corners was done by using a no. 15 blade. The horizontal incision was done slightly palatal to the crest of the alveolar ridge (paracrestal incision) through the keratinized mucosa to enhance visibility and ensure primary flap closure. Vestibular releasing incisions, one tooth before and after the defect area were made to enhance visibility and ensure tension free flap retraction and closure. After that, a full mucoperiosteal flap was raised to expose the alveolar defect. Slight scrapping of the bone was done to remove any soft tissue tags from the periosteum, but no cortical perforations were made.

Following that, bone caliber was used to estimate the defect's width and height. Following that, these measures were utilized to determine the amount of bone should be harvested from the symphysis. in the control group or the shape and thickness of tooth root block in the study group. (Figure 1,2)

- **Control Group:**
  - **Anesthesia**

Harvesting of the intraoral symphysis block was done under local anesthesia. Bilateral incisive & lingual nerve block anesthesia were administered using articaine 4% with 1:100,000 epinephrine.

- **Incision design for surgical access to symphysis**

Vestibular/alveolar mucosa incision

1 cm beyond the mucogingival junction, a horizontal incision was done that extended all the way to the distal part of each canine. Between the canine and premolar, a vertical incision was made anterior to and above the mental foramen. To cut through the mentalis muscle, a horizontal incision was made in the apicolingual direction, toward the bone. It maintained the mentalis muscle and 3 mm of periosteum, which were later used to reattach the mentalis muscle. A full thickness incision was performed below this point, and a mucoperiosteal flap was reflected to the level of the pogonion at the base of the mandible.

The most inferior portion of the mentalis muscle's periosteal attachment was keept intact, however it had the most intra operative bleeding and the highest risk of flap opening and potential for scarring

- **Reflection of flap**

Exposure of the symphyseal bone was undertaken using periosteal elevators and the mental nerves were visualized bilaterally.

- **HARVESTING RULES Rule of 5's**

Misch [18]in 1992, suggested a safe surgical procedure to harvest a bone block graft from the mandibular symphysis that helps to protect the mandibular symphysis region's neuro-vascular components. Rectangular block was made using piezoelectric tips and the four bony cuts were performed as follows; the superior cut was made 5 mm below root apices to prevent injury to toothroots and mandibular inferior cortex. The inferior was made 5 mm above the lower border. Vertical cuts were made at least 5 mm away from the mental foramen.

Depth of the cut was through the outer cortex and to the opposite cortical plate to obtained monocortical graft. Lingual cortex wasn'tperforated. When the desired bone cuts have been completed chisel &mallet were used to deliver the graft. The midline symphysis was usually left intact. (Figure 5.6)

- **Donor site management after graft harvest**

The donor site was then irrigated and sealed by collagen sponge to aid in hemostasis and control wound healing.

- **Suturing**

(4/0 non-resorbable polypropylene)suture, was used to suture the intrasulcular incision while using interrupted suturing techniques. in order to do suturing for the vestibular incision: it was done in two levels, first the muscle was sutured then the mucosal tissue.

- **Study Group:**
  - **Anesthesia** Inferior alveolar nerve block, lingual nerve block and buccal nerve block were done using articaine 4% with 1:100,000 epinephrine.
  - **Incision design**

Horizontal incision was made at anterior border of ramus and extended as far as distal aspect of the second molar continuing along cervical lines of the last two teeth ending at mesial aspect of first molar using scalpel no.15.

[6]Artinibsa 40mg/ml with 1:100000 adrenaline, Inibsa Dental S.L.U, Spain.

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- **Reflection of flap**

Full mucoperiosteal flap was reflected using mucoperiosteal elevator.

- **Bone removal**

Was done using piezoelectric device, After the flap was reflected a sufficient amount of bone was removed from the buccal and distal aspects around tooth (guttering technique) so that tooth is exposed which facilitate its extraction without fracture to be in intact condition to be used as a block graft.

- **Tooth delivery**

After exposing the extracted tooth sufficiently, a forceps and/or elevators were used to deliver the tooth out of its socket.

- **Wound debridement**

After tooth extraction, the wound was irrigated with saline to remove bone debris and any residual tissue was removed using curette and sharp edges were moved using bone file.

- **Suturing**

The first suture was placed at the corner of the flap to ensure correct repositioning of the flap the rest are placed along posterior incision using a(4/0 non-resorbable polypropylene) suture. (Figure 3)

- **Preparation of tooth**

After tooth extraction it was prepared as following:

1. The extracted tooth was immersed in 70% ethyl alcohol to be disinfected.
2. The tooth was properly curetted to remove all soft tissues, debris and calculus.
3. The tooth was then decapitated at the cement-enamel junction using a rotating carbide bur under copious saline irrigation.
4. The roots were be split in case of multi-rooted teeth.
5. To improve ankylosis between the graft and the defect site the layer of cementum at the respective downward aspects of the root was carefully removed using a Diamond bur (coarse, round end taper) under copious irrigation until the underlying dentin was entirely exposed.
6. The pulp tissue was extirpated with the K-file.
7. The extracted tooth was trimmed to fit very closely over the recipient bone using the measured defect site as a guide.
8. the tooth root block after adequate trimming was immersed in dentin cleansing solution[7] for 10 minutes, followed by the buffer saline solution (Dulbecco's Phosphate) for 2-3minutes to obtain a graft free of all the organic debris, resulting in a bacteria-free sterile graft. (Figure 4)

- **Graft fixation**

In both groups, the receiving site was analyzed for any bony irregularities then slightly flattened by using a round carbide bur under meticulous water (i.e., saline) cooling. to improve the contact between both TR and AB grafts and the recipient site. Moreover, cortical perforations were made to facilitate blood supply.

Both autogenous tooth root graft and autogenous bone graft were predrilled and fixed using one to two titanium osteosynthesis screws of 1.2 mm diameter of suitable length (8mm, 9mm or 10 mm) depending on the defect and available host bone thickness. (Figure 7)

- **Wound Closure &Suturing**

Peri-osteal releasing incisions were made to enable coronal advancement of the mucoperiosteal flaps. Tension-free coverage of the surgical site was done by means of horizontal mattress sutures taken 5 mm away from the incision line in addition to another row of interrupted and vertical mattress sutures 3mm from the incision line to ensure a watertight, primary flap closure using(4/0 non-resorbable polypropylene) suture material. (Figure 8)

Postoperative management

All patients were advised to maintain good oral hygiene, prevented from chewing anything with a solid texture, apply ice to the area on 1st day, then warm packs were applied for two days starting from the 2nd day.

- **In both groups, postoperative medication composed of:**
  - Antibiotic course was continued for 7 days after surgery.
  - Ibuprofen[8] 400 mg as analgesic, 3 times daily.
  - 0.2% chlorohexidine gluconate[9] solution rinse daily for 2 weeks
  - sutures were removed after 10 days.

Evaluation and follow up

A) Clinical Evaluation:

1- Postoperative Healing:

- Atthe immediate follow up period, the soft tissue healing was assessed. Any signs of inflammation, wound dehiscence, graft exposure or infection were recorded after two weeks postoperatively.
- Pain and edema were evaluated for two weeks postoperatively.

[7]Kometa Bio, New Jersey, USA.

[8]Brufen 400mg tablets, ABBOTT, Egypt.

[9]Listermix Plus mouthwas h, SIGMA, Egypt.

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B) Radiographic Evaluation:

Cone Beam Computed Tomography scan were taken preoperatively **(T_x)**, six months postoperatively **(T_6)**.

All patient scans were taken by the same CBCT machine using fixed imaging parameter at every scan. All digital imaging and communication in medicine (DICOM) data were then analyzed using OnDemand3D® software20. Linear measurements were done using BlueSkyPlan® software21

1- Assessment of residual bone surface area:

- **Residual Bone surface area (T_x):**

During preoperative assessment, the residual bone surface area was measured as the area from the alveolar crest to 10 mm level between buccal and lingual cortical walls.

- **Postoperative Bone surface area (T_6):**

The Bone surface area is measured six months postoperatively at the same level of 10-mm from the alveolar crest referred to as T6.

- **Amount of Bone Gain (BG):**

The horizontal bone gain resulted from the ridge augmentation was measured. This bone gain was calculated as the difference between the original bone surface area and bonesurface areaafter six months at 10-mm level, this calculation was done using T_x (bone surface area before grafting), T_6 (bone surface area six months after grafting)

Bone Gain (BG)=T6 – Tx

1 Bilateral case using autogenous bone graft on right side and tooth root graft on the left side

Figure 1:clinical preoperative photograph showing area of defect

Figure2:Intra-operative clinical occlusal photographs showing the initial situation after flap reflection

Figure 3:An intraoperative clinical photograph showing site after donor tooth extraction

Figure 4: clinical photograph showing tooth root graft after

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Figure 5:An intraoperative clinical photograph showing the chin donor site after block removal.

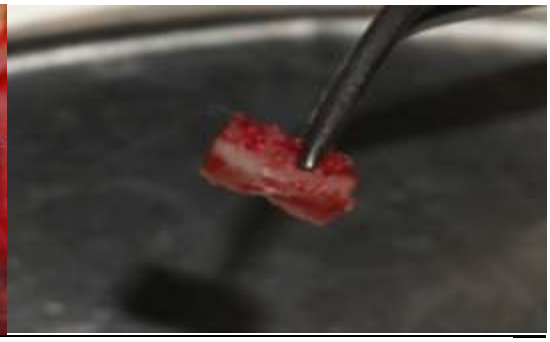

Figure 6:An intraoperative clinical photograph showing thechin bone

Figure 7 : An intraoperative clinical photograph showing fixation of tooth root graft and chin block graft

Figure 8: An intraoperative clinical photograph showing primary tension-free flap closure

Statistical analysis and data interpretation:

Data were fed to the computer and analyzed using IBM SPSS Corp. Released 2013. IBM SPSS Statistics for Windows, Version 22.0. Armonk, NY: IBM Corp.

- Qualitative data were described using number and percent.
- Quantitative data were described using mean, standard deviation for normally distributed data after testing normality using Shapiro-Wilktest.
- Significance of the obtained results was judged at the (0.05) level.
- Student t-test was used to compare 2 independent groups.

III. RESULTS

Demographic data

This study was conducted on fourteen patients; seven females and seven males who met the inclusion criteria. Patients' age ranged from 18 to 40 years with a mean age of 29±11 years. A total number of 14 horizontal ridge augmentation procedures were performed.

The control group included seven horizontal ridge augmentations made in seven patients, with a mean age of 29±10 years.

In the study group, also seven horizontal ridge augmentations were made in seven patients with a mean age of 29±8 years

Clinical Evaluation:

No significant intra- or post-operative complications or clinical signs of infection were

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observed in most of the cases except in one case in control group showed reopening of the flap in the donor site in mandibular symphysis area.

Subjects in the control group did not report any sensory disturbance along the mental & incisive nerves. One thing to note was that postoperative edema lasted for longer period in the control group, one to two days longer

Radiographic Evaluation:

Assessment of Bone surface area

1- Residual Bone surface area (Tx):

- During preoperative assessment, the **Residual Bone surface area** was measured as the area from the alveolar crest to 10 mm level between buccal and lingual cortical walls referred to as **(T_x).**
- Mean Residual Bone surface area values were comparable (p=0.200) in both groups and amounted to 40.88±2.64 mm^2 in AB group and 38.10±3.58 mm^2 in TR group respectively.
- Mean residual Bone surface area values were not significantly different between both groups

2- Bone surface area after six months (T_6):

- The Bone surface area is measured six months postoperatively at the same level of 10-mm from the alveolar crest referred to as **(T_6).**
- Mean Bone surface are values after six months were comparable (p=0.645) in both groups and amounted to 66.32±8.85 mm^2in AB group and 76.80±10.62 mm^2 in TR group respectively.
- Mean Bone surface area values after six months were not significantly different between both groups.

3- Amount of Bone Gain (BG):

- In all patients of both AB (7/7) and TR groups (7/7),
- The horizontal bone gain resulted from the ridge augmentation after six months was measured.
- It was calculated by subtracting the residual bone surface area **(Tx)** from bone surface area after six months **(T6).**

  Bone Gain (BG) = T_6 - T_x
- Mean Bone Gain values after six months amounted to 25.44±5.38 mm^2in AB group and 38.70±7.69 mm^2 in TR group consequently.
- The resulting differences between both groups were statistically significant (p=0.03*).

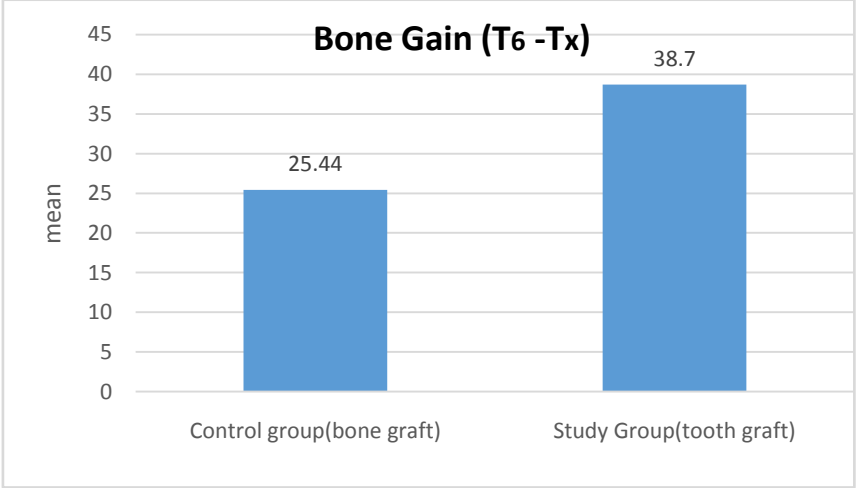

Table 1: Assessment of bone surface area between studied groups.

	Control Group (AB)	Study Group (TR)	Test of significance
T_x	40.88±2.64	38.10±3.58	t=1.39 p=0.200
T_6	66.32±8.85	76.80±10.62	t=0.478 p=0.645
Bone Gain T_6 -T_x	25.44±5.38	38.70±7.69	t=2.76 p=0.03*

t: Student t test, *statistically significant, all parameters described mean±SD

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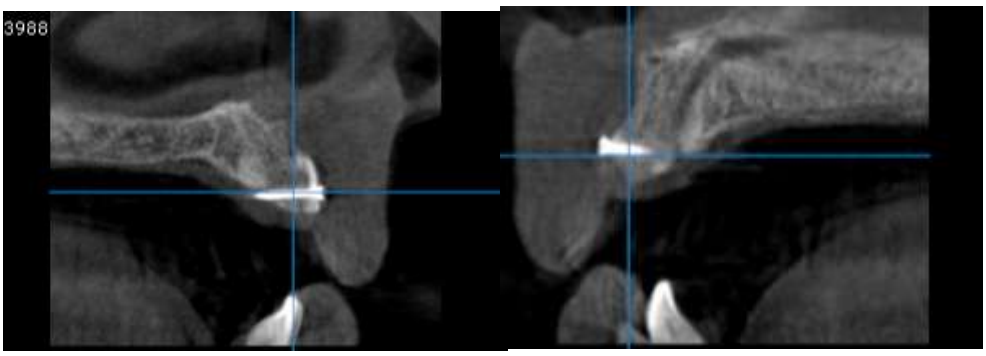

follow-up radiograph after 6 months showing bone gain in tooth root graft

follow-up radiograph after 6 months showing bone gain in autogenous bone graft

IV. DISCUSSION

In implant dentistry, the rehabilitation of locally compromised alveolar ridges has become an essential therapeutic component. A typical and efficient therapeutic treatment for the reconstruction of deficient alveolar ridge defects is lateral bone augmentation prior to implant placement.[19]

Autogenous bone is still regarded as the best grafting material for the reconstruction of horizontal alveolar ridge deficiencies in the majority of technical approaches, primarily because of its osteogenic and osteoinductive abilities. However, some potential drawbacks are related to its availability in certain intraoral donor sites, as well as an increased risk of morbidity and discomfort for patients during its harvesting process, extended hospitalization and some complications deriving directly from the technique, which occur in some 30–50% of cases, the most serious being neurosensory disturbance, which can occur when bone is harvested from the chin. This can also cause aesthetic changes to the patient's facial contours.[20,21].

Autogenous dentin grafts, which can be employed in block or particulate form, are a novel therapy alternative to autogenous bone grafts for grafting purposes. Kim et al [22]showed that the autogenous tooth had outstanding repair abilities due to its osteoconduction, osteoinduction via blood wettability, creeping substitution, and space-maintaining capacities. It can be used in localized ridge augmentation with mild flaws by preserving a space over a defined period. Park et al.[23]

The hypothesis of the study was to compare between autogenous tooth root graft (TR) and autogenous bone block (AB) as an onlay grafts lateral augmentation of the maxillary alveolar ridge radiographically as for bone gain.

Regarding assessment of bone surface area, our data showed statistically significant differences between two groups in amount of bone gain (p=0.03*).

the radiographic assessment after six months revealed that amount of bone gain was higher in Tooth group than bone group where there was statically significance between two groups The results of our study are in accordance with those of Schwarz et al, [24]who showed higher values of bone gain in TR group in comparison with AB group after 24 weeks amounted to 11.01 ± 4.37 mm^2 in TR as compared to 8.07 ±5.64 mm2 noted in the AB group. Similarly, Parvini et [25] al showed that tooth root group showed bone gain after 26 weeks higher than bone group with 22.07 ± 12.98 mm^2 in the TR group and 12.42 ± 10.11 mm^2 in the AB group (p = 0.03*). Our study disagreed with the radiographic results obtained from (Elraee, Abdel Gaber, et al., 2022) [26]in which the overall mean radiographic ridge width gain RRWG was 3.61±0.61 mm and 3.41±1.15 mm in tooth root and Autogenous bone groups respectively without any statistically significant difference between them (p=0.062).

Higher bone gain with tooth root (TR) blocks is mainly due to less pronounced graft resorption values in the TR group. Less graft resorption can be attributed to basal ankylosis and subsequently replacement resorption of the exposed dentinal matrix facing the alveolar bone and

undermining replacement of the dentinal matrix of TR grafts by a vital (i.e. bleeding) bone-like tissue structure.

To the best of our knowledge, tooth root block grafts (TR) can restore bone volume and quality which are necessary for the primary stability of implants as compared to other approaches, avoids the need for bone harvesting procedures, and the subsequent surgical damage at donor sites. Because no additional materials are required, the cost of the surgery is also decreased. These were represented by the improvement of clinical and radiographic parameters that were involved in evaluating the results of this study throughout its different time intervals of follow-up. The use of tooth root block technique is, however, restricted in situations where large bony defect is needed, and patients without donor teeth or roots cannot utilize this procedure.

V. CONCLUSION

Tooth root graft higher in bone gain than tooth graft

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