Augmentation of the localized bony defects with synthetic bone substitute in simultaneous dental implant surgery (Clinical study)

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ABSTRACT

Background: Simultaneous and staged guided bone regeneration (GBR) is one of the several surgical techniques that have been developed in the past two decades to regenerate bone and thus to allow implant placement in compromised sites (fenestration and dehiscence). It is a surgical procedure that consists of the placement of a cell-occlusive physical barrier between the connective tissue and the alveolar bone defect. The treatment concept advocates that regeneration of osseous defects is predictably attainable via the application of occlusive membranes, which mechanically exclude non-osteogenic cell populations from the surrounding soft tissues, thereby allowing osteogenic cell populations originating from the parent bone to inhabit the osseous wound. Augmentation utilizing guided bone regeneration (GBR) has become a major treatment option to provide optimal bone to support Osseointegrated dental implants. One of the objectives of GBR is the formation of new bone at sites deficient in bone volume. Another objective is to treat fenestrations and dehiscence at implant surfaces as well as defects associated with simultaneous implant placement. GBR has allowed for placement of restorations at a more ideal location in the oral cavity, thus improving esthetics and functions. This study aimed to improve the alveolar ridge width by using of synthetic bone substitute covered by resorbable collagen membrane in simultaneous dental implants placement and to compare the ridge width at three levels (crestal, middle and apical) clinically (osteometer) and radiographically (CT) pre operatively and postoperatively.

Materials and methods: This prospective study was conducted in teaching dental hospital in College of Dentistry of Baghdad University on (15) patients with (21) dental implant with insufficient bony support for simultaneous dental implants , this study extended from March 2013 to the end of December 2013.

All patients were treated at the time of implantation by using a synthetic bone substitute covered by resorbable collagen membrane .All patients examined clinically by osteometer and radio graphics (CT) to assess ridge width and height and bone density.

Results: Clinically and radiographically evaluation showed increasing of ridge width after 6 months of healing period at three levels: apical, middle and crestal, statistically, there were no significant differences between ridge width gain measured clinically and radio graphically and gender and age groups. In this study the success rate (95.24) % in (20) dental implant and only (1) dental implant was failed (4.76) % at age 47 years old.

Conclusion: There was significant increase in ridge volume that augmented at the time of implantation to become sufficient width for support implant esthetically and functionally. This study revealed that there was no effect in gender and age on bone augmentation with synthetic bone substitute.

Keywords: GBR, Simultaneous dental implant, osteometer, CT, ridge width and height and bone density. (J Bagh Coll Dentistry 2015; 27(1):151-158).

INTRODUCTION

Dental implants are considered nowadays by most of patients and clinicians as the first line of treatment in restoring missing teeth. Over the last fifty years, when teeth are lost due to trauma, infection or advanced gum disease, insufficient bone can be found at the missing teeth area which can influence the aesthetics, and long term prognosis of the dental implants and their prosthetic super structure. In such cases, dental implant therapy would not be an option without horizontal and/or vertical bone augmentation [(1)].Guided bone regeneration (GBR) is a reconstructive procedure of alveolar ridge using membranes. This procedure is indicated when there is no sufficient bone for implantation, or in the case of optimal implant installation for esthetic or functional needs.

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GBR can be performed before implant placement, when there is not enough bone for initial stability of implants and less predictable outcomes (staged approach), or performed simultaneously with implantation (combined approach). GBR techniques have been used for vertical and horizontal ridge augmentations with acceptable results [(2)].

Guided bone regeneration is based on principles of guided tissue regeneration (GTR). [(3)] GTR was first developed in the early 1980s by Nyman et al.[(3)] This concept is based on the principle that specific cells contribute to the formation of specific tissues [(4)].Exclusion of fast-growing epithelium and connective tissue from a periodontal wound for 6-8 weeks allows the slower growing tissues including osteoblasts, cementoblasts, and periodontal ligament cells, occupy the space adjacent to the tooth [(3,5)]. GBR concept employed the same principles of specific tissue exclusion but was not associated with teeth.

Calcium phosphate (CaP)-based materials that have been used in craniofacial surgery for more than 100 years represent an attractive candidate because of their outstanding properties as bone substitutes and as drug delivery vehicles [6,7,8,9]. Due to their self-hardening and appropriate mechanical properties, high osteoconductivity, excellent surface chemistry and surface topography to bone defect surfaces,CaP-based biomaterials can be used with outstanding results in a number of dental applications, including ridge augmentation, implant coating, bone defect fill and sinus lift [10].

There are five criteria considered important in the design of barrier membranes that are used for GTR. These include biocompatibility, cell occlusiveness, space making, tissue integration and clinical manageability.

Various types of materials have been developed, which can be grouped together as either non resorbable or irresorbable membranes [11, 12].

Computerized tomography (CT)-based dental imaging for implant planning and surgical guidance carries both restorative information for implant positioning, as far as trajectory and distribution, and radiographic information, as far as depth and proximity to critical anatomic landmarks such as the mandibular canal, maxillary sinus, and adjacent teeth[13].

The success of GBR is one of the important parts of implant dentistry. The first generation definition of success was the ability of complete cover of a dehisced or fenestrated implant surface with regenerated hard tissue [14]. The second-generation definition of success was the regeneration of a sufficient dimension of bone to withstand functional forces overtime [15].

MATERIALS AND METHODS

Study sample:

This study was based upon clinical, radiographical and surgical data, a total of (21) dental implants in (15) Iraqi patients aged 20-50 years old, 7 males and 8 females attended to the Teaching Dental Hospital in College of Dentistry of Baghdad University. This study extended from March 2013 to the end of December 2013.

Selective criteria of the study sample:

1. The patients were selected according to medical and potential implant site evaluation; sample individual with no history of any systemic diseases.
2. Cases selected with good oral hygiene, non-smokers and no complications were recorded during previous dental treatments.
3. Age group ranged from 20 to 50 years old.
4. Potential implant site:
   A. The target regions are anterior and premolar regions (traumatic zones and sinus zone "only 2nd premolar").
   B. Implant sites with defect at maximum width of alveolar ridge ≤5 mm.(insufficient width).
5. Patients case record:
   Following data were recorded in specially prepared case sheet form (see the case sheet in the appendix):
   A. General information including name, age, gender, address, occupation and phone number.
   B. Etiology of Edentulism: Caries, trauma, periodontal disease and occlusal trauma.

Clinical examination:

Extra oral:

Facial asymmetry was examined and smile line either dental or gingival in addition to the mouth opening.

Intra oral

All teeth were examined ,the gingival, periodontal conditions and teeth mobility, the implant potential area was examined carefully for missing teeth to be replaced by DI, hygiene, pathological lesions, depth of vestibule, width of alveolar ridge, ridge height, vestibular concavity, vertical bone resorption, mesiodistal distance and gingival thickness.

Radiographical examination:

MSCT scan were performed preoperative for each patient to determine the ridge width and bone density at three levels (Crestal, middle and apical) on CT slices.

After 6 months the same CT repeated for each patient and determined the ridge width and bone density also at three levels (Crestal, middle and apical).

Materials:

Bone substitute of lifting-osteon II (dentium system, Korea), this is 100% synthetic osteoconductive bone graft substitute composed of hydroxyapatite (HA) 70% and beta tricalcium phosphate(B-TCP) 30%,Collagen type membrane which is a resorbable membrane 0.3mm in thickness, size (10×20., 15×20, 20×30)mm is used, (dentium system, Korea)**,** Dental implant: The dental implants used in this study are dentium system (Korea)**,** Implant surgical kit (dentium system, Korea) and Implan micromotor**:** Controlling speed micro motor (W&H; Austria).

Methods:

Radiographic and clinical evaluation:

A multi slices spiral Computed tomography (MSCT) (Philips , Brilliance 64) was Performed in Al-Karkh General Hospital for each patient to assess the ridge height , bone density and ridge width at three levels 1st, crestally and 2nd about 3mm apically from the 1st level and 3rd level about 3mm apically from 2nd level.

Clinically use ridge caliper (osteometer, Germany) and reamer in measuring bone width also at three levels same as to measurement by CT, the reamer inserted in the gingiva at top of the crest to measure the thickness of the gingiva .the bucco-palatal width was measured by ridge caliper (Osteometer) after determine the level of ridge crest , this measurement reveal the net of total width of ridge bone at three levels same to that on CT evaluation pre operatively, record these measurement that obtained by CT and Osteometer.

Surgical procedure:

All patients were treated under local anesthesia using lidocaine (France) by infiltration technique, the oral mucosa in the implantation site was incised palatal to the defect in alveolar ridge, three sided full thickness flap was raised to expose the implant site.

The point of insertion on the bone was marked with the help of a Lindemann guide bur; this was followed by the use of a Lindeman first drill at a bur speed of 800rpm to 1000 rpm with copious irrigation with normal saline. The depth stop of all instruments at selected implant length that determined according to ridge height that obtained from MSCT. Then use a final drill according to width of ridge that determined previously according to the diameters measurement obtained by CT and Osteometer. The implant is opened from the sterile packaging and placed in implant recipient site with hand pressure, the fenestration (apicaly) or dehiscence (cervicaly) may be occurred due to insufficient width of alveolar bone for support the simultaneous placement dental implant. The B-tricalcium phosphate sterile resorbable substitute was used, these material injected into the defect, the graft material mixed with normal saline in tube of material and with blood from the recipient site at the defect site. After placement of bone substitute the membrane was covering the bone substitute, collagen type (Korea) which is resorbable membrane. Select the size of membrane according to defect morpholgy, the membrane Adapted to the defect, any exposed material was removed. Next the periosteium of mucoperiosteal flap cut at its base to mobilize the flap and allow to cover the bone substitute without tension, The flap was closed over the graft and implant using interrupted sutures silk (3/0). post operatively broad spectrum antibiotic (Azithromycin 500mg ,1 Tab per day) was prescribe for 1 week, analgesic (Paracetamol 500 mg) on need and Chlorohexidine 0.2% mouth rinse (Lacalute company, Germany) used for 2 week (1minutes, two times daily). Two weeks post-surgery the sutures were removed.

Follow up:

After healing period of 180 days another x-ray (MSCT) was repeated again for each patient the measurements like pre-operative were taken to evaluate width and density of the alveolar bone ridge at three levels at (crestal, middle, apical) Clinically the ridge width was measured by ridge caliper (Osteometer) at three levels as same as pre operatively.

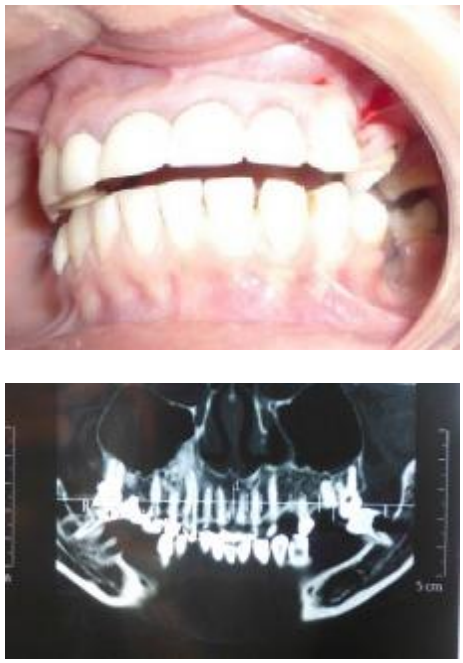
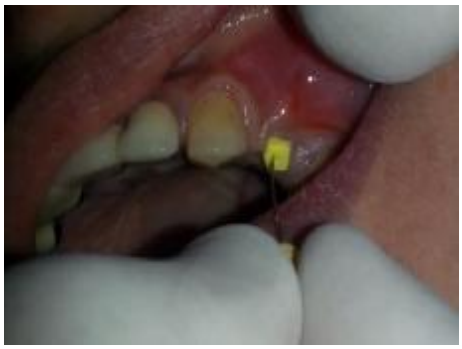
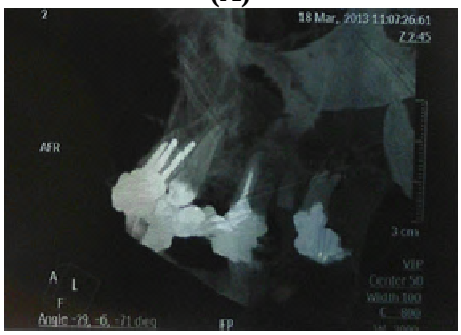


Figure 1: Pre operative alveolar ridge and pre operative CT at premolar area showing implant zone

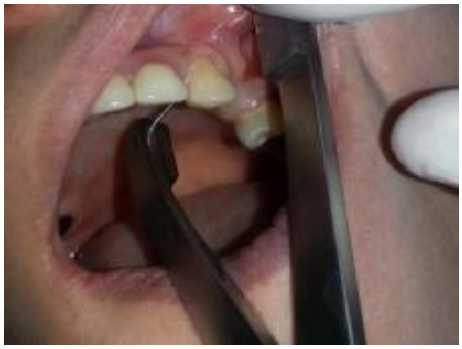


(A)

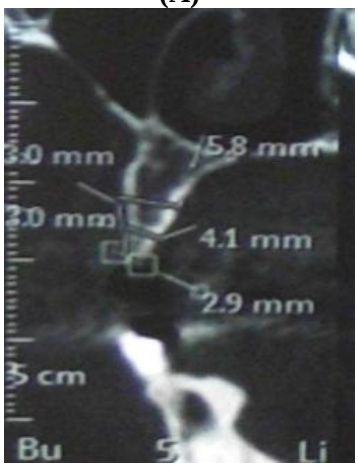


(B)

Figure 2: (A) Using reamer to measure gingival thickness Pre-operative. (B)Pre operative CT view implant site

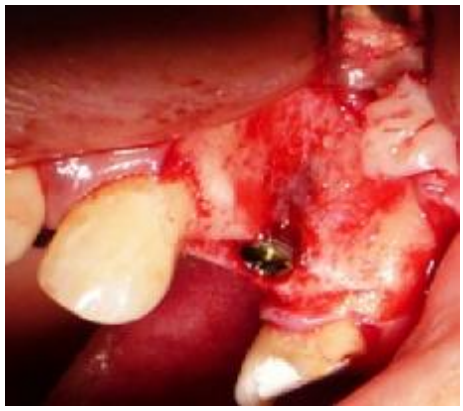


(A)

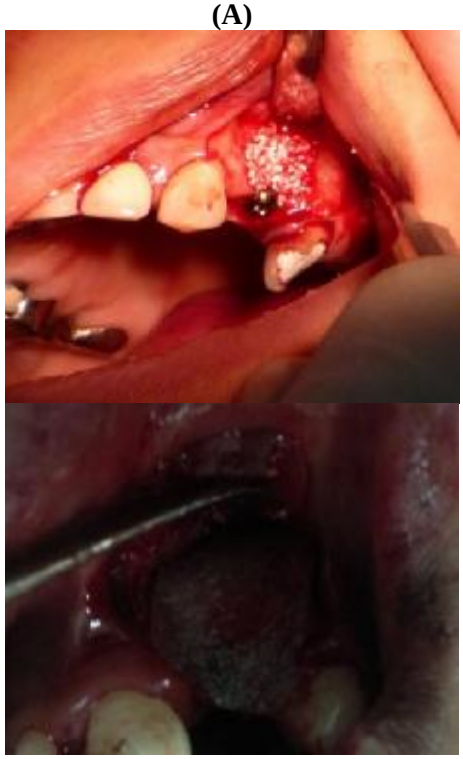


(B)

Figure 3: (A).Pre operative measurement the ridge width clinicaly by osteometer (B).Preoperative alveolar ridge width measurement on CT at three levels



(A)



(B)

Figure 4: (A) Fenestration and dehescince at premolar implant zone (B) Placement of bone substitute on bony defect (fenestration and dehescince) and Placing of the collagen membrane over bone substitute

RESULTS

Clinical measurements of the width of the alveolar ridge

Table 1 showed the descriptive statistics and comparison of the width of the alveolar ridge pre- and post-operatively at different levels. Generally, the width of the ridge increased significantly post-operatively at different levels specially at the apical level.

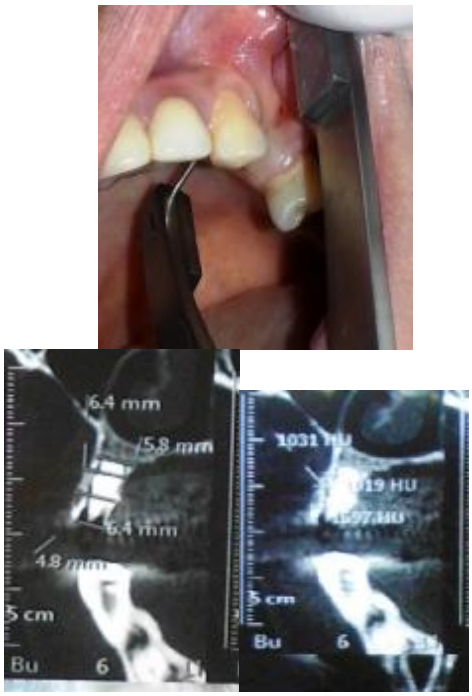


Figure 5: Post operative alveolar ridge width clinicaly by osteometer and CT and density measurement at three levels on CT after 6 months

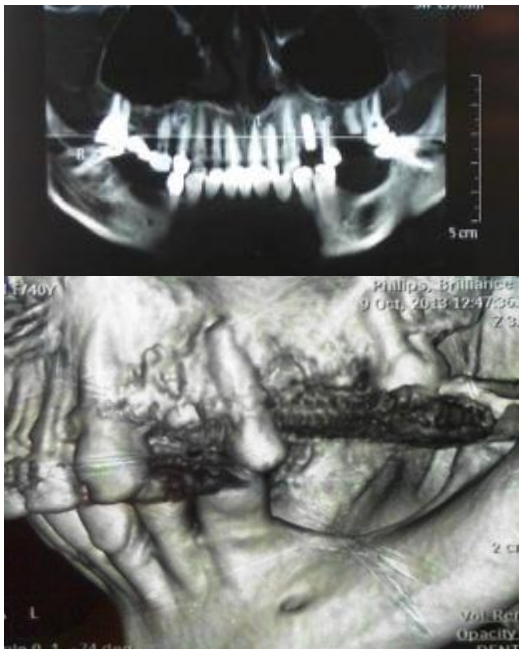


Figure 6: Implant on CT in relation to adjacent strctures andBone substitute on CT after 6 months

Figure 7: Prosthetic part inside patient mouth after cementation

Computed tomographic measurements of the width of the alveolar ridge

The descriptive statistics and comparison of the width of the alveolar ridge pre- and post-operatively at different levels measured by C.T. were presented in table 2. The results revealed a significant increase in the width of the alveolar ridge post-operatively at the different measured levels.

Assessment of the bone density

Table 3 show mean bone density measured with C.T. both pre- and postoperatively at the same levels. The results indicated that there is significant increase in bone density post-operatively in comparison with pre-operative state.

Comaprison the method of alveolar ridge measurements

1. Comaprison the method of alveolar ridge measurements pre-operatively

Table 4 showed a comparison of pre-operative measurement of ridge width between the clinical and C.T. methods at the three levels. Statistically, the width of the alveolar ridge is higher clinically than with C.T. with no significant difference between the two methods at the crestal and middle levels, while significant difference was found between the methods at apical level.

Table 1: Descriptive statistics of the width of the ridge (mm.) measured clinically and comparison between the pre and post-operative states

Levels	Pre-operative				Post-operative				Comparison	
	Median	Mean	S.D.	S.E.	Median	Mean	S.D.	S.E.	Wilcoxon Signed Ranks test	p-value
Crestal	3.75	3.38	1.09	0.24	5	5.10	0.85	0.19	-3.645	0.000 (HS)
Middle	5	4.63	0.79	0.18	7	6.95	1.10	0.25	-3.857	0.000 (HS)
Apical	5.25	5.35	0.86	0.19	9	8.68	1.17	0.26	-3.967	0.000 (HS)

Table 2: Descriptive statistics of the width of the ridge (mm.) measured by C.T. and comparison between the pre and post-operative states

Levels	Pre-operative				Post-operative				Comparison	
	Median	Mean	S.D.	S.E.	Median	Mean	S.D.	S.E.	Wilcoxon Signed Ranks test	p-value
Crestal	2.65	2.97	0.91	0.20	5.3	5.31	0.97	0.22	-3.921	0.000 (HS)
Middle	3.85	3.86	0.80	0.18	6.5	6.80	1.56	0.35	-3.922	0.000 (HS)
Apical	4.65	4.66	0.88	0.20	7.1	7.33	2.10	0.47	-3.922	0.000 (HS)

Table 3: Descriptive statistics of the bone density (Hounsfield unit) measured by C.T. and comparison between the pre and post-operative states

Levels	Pre-operative				Post-operative				Comparison	
	Median	Mean	S.D.	S.E.	Median	Mean	S.D.	S.E.	Wilcoxon Signed Ranks test	p-value
Crestal	421	492.25	260.79	58.32	825	820.50	354.78	79.33	-3.920	0.000 (HS)
Middle	552.5	580.10	247.08	55.25	967.5	923.15	387.54	86.66	-3.211	0.000 (HS)
Apical	538.5	550.00	242.64	54.25	693	765.55	230.93	51.64	-3.323	0.000 (HS)

Table 4: Comparison between the two methods used to measure the pre-operative ridge width

Levels	Clinically				C.T.				Comparison	
	Median	Mean	S.D.	S.E.	Median	Mean	S.D.	S.E.	Wilcoxon Signed Ranks test	p-value
Crestal	3.75	3.38	1.09	0.24	2.65	2.97	0.91	0.20	-1.852	0.064 (NS)
Middle	5	4.63	0.79	0.18	3.85	3.86	0.80	0.18	-0.784	0.433 (NS)
Apical	5.25	5.35	0.86	0.19	4.65	4.66	0.88	0.20	-2.860	0.004 (HS)

2.Comaprison the method of alveolar ridge measurements post-operatively

Table 5 showed a comparison of post-operative measurement of ridge width between the clinical and C.T. methods at the three levels. Generally, the width of the alveolar ridge is higher clinically than with C.T. with a significant difference between the two method at the middle and apical levels, while non-significant difference was found between the two methods at crestal level.

Table 5: Comparison between the two methods used to measure the post-operative ridge width

Levels	Clinically				C.T.				Comparison	
	Median	Mean	S.D.	S.E.	Median	Mean	S.D.	S.E.	Wilcoxon Signed Ranks test	p-value
Crestal	5	5.10	0.85	0.19	5.3	5.31	0.97	0.22	-0.635	0.525 (NS)
Middle	7	6.95	1.10	0.25	6.5	6.80	1.56	0.35	-2.316	0.021 (S)
Apical	9	8.68	1.17	0.26	7.1	7.33	2.10	0.47	-2.483	0.013 (S)

Percentage of success and failure rates

Table 6 showed percentage of success rate (95.24%) for (20) dental implant and percentage of failure rate (4.76%) for (1) dental implant.

Table 6: Percentages of success and failure

State	No.	%
Success	20	95.24
Failure	1	4.76
Total	21	100

DISCUSSION

In this study, there were 15 patients with insufficient bony support for 21 dental implant placement, 7 males (46.67%) and 8 female (53.33%)

According to statistical analysis using Wilcoxon Signed Ranks test, this study revealed that was highly significant increase in ridge width at three levels (crestal. middle and apical) that measured clinically and radiographically (CT). so the mean value of ridge width at (crestal.middle and apical) levels measured clinically preoperative were (3.38 , 4.63 and 5.35)mm and after 6 months of healing period these measurements show increase in width resulting good bony support and adequate ridge width for implant placement, so, mean value of ridge width at (crestal.middle and apical) levels measured clinically postoperative were (5.10 , 6.95 and 8.68) mm respectively. CT scan also used for assessment of ridge width pre and post operatively at three levels (crestal , middle and apical) and also presented highly significant increase in ridge width at three levels , the mean value of ridge width that measured by CT preoperatively were (2.97, 3.86 and 4.66) mm crestal ,middle and apical in sequence . And also after 6 months the all patients reexamined by CT and we found there were increase in ridge width, so, the mean value of ridge width became (5.31, 6.80 and 7.33) mm.

It has been suggested that that increasing in ridge width is due to the proper selection of patients (healthy ,non smokers and patients follow our oral care instructions) and use of best synthetic bone substitute consist of beta tri calcium phosphate (B-TCP) and hydroxyapatite (HA), similar to that human cancellous bone covered by resorb able collagen membrane made a cell-occlusive physical barrier between the connective tissue and the alveolar bone defect. This barrier prevents the migration of the soft tissue into the defect and creates a protected space in which the blood clot and the graft are stabilized. Epithelial and connective tissue cell migration is avoided and the slow migrating osteogenic cells can proliferate, with subsequent formation of new bone leading increase in ridge width and the membrane was absorbable ,so no need second surgical operation to remove it and it was biocompatible does not produce any side effect. We select all our patients were non smokers to avoid the complication and failure because of in smokers patients the blood supply to the soft and bony tissues was much reduced , and that there are higher risks of postoperative infections . These were supported by Rosenberg et al. [16], In a retrospective analysis of a longitudinal study of GTR procedures reported a 42% failure rate after at least 4 years, however, 80% were in patients who smoked at least 10 cigarettes per day for 5 years. So we were selected all our patients are nonsmokers to avoid the complication and failure and increase the success rate (95.24%).

The bone density of alveolar ridge that measured preoperative at three levels by CT range from (D2-D5) show highly significant increase in comparison between pre and post operative measurements, while in postoperative, bone density range from (D1-D4)

The success rate in our study (95.24%) while failure rate (4.76%), these were supported by Fugazzotto in 1997 [17] published an article on this subject , failure and success rates of 626 implants either placed in regenerated alveolar bone or treated with guided bone regeneration to rebuild bone over implant fenestrations or dehiscences were evaluated. The cumulative success rate of implants in function in regenerated bone for 6-51 months was 93.8%.

Reasons for high success rate in our study were:

1. Resorbable collagen membrane protect bone substitute and stabilize blood clot.
2. Good instruction given to patients.
3. Proper selection of patients (healthy, non smokers and no medication), these in agreement with Buser et al [18] report successful ridge augmentation with GBR in humans using an e-PTFE membrane and tenting pins.

All patients were examined clinically by using osteometer and also radiographically (CT) these two methods were used to assess the ridge width ,statistically , generally the width of the alveolar ridge is higher clinically than with C.T with there were no significant differences between these methods in determination of ridge width at crestal and middle preoperative. While at apical level the width of the alveolar ridge is higher clinically than with C.T, In post operative re-examination ,statistically, generally revealed the width of the alveolar ridge is higher clinically than with C.T. a significant difference between the two method at the middle and apical levels, while non-significant difference was found between the two methods at crestal level These differences were due to difficult to assess clinically precisely.

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الخلاصة

خلفية عن الدراسة :عملية إعادة توليد العظام التزامنيه والتتابعية هي واحدة من العديد من التقنيات الجراحية التي تم تطويرها في العقدين الماضيين لتجديد العظام و بالتالي السماح بزرع العظام في مواقع الخلل(نقص العظم) ذلك هو إجراء العمليات الجراحية التي تتكون من وضع عظم إصطناعي مغطى بغشاء فاصل بين النسيج الضام اللثوي والعظم السنخي للفك . مفهوم العلاج يتضمن بأن تجديد العيوب العظمية هو متوقع ويمكن بلوغه عن طريق تطبيق الأغشية المسدودة ، والتي تستبعد ميكانيكيا التجمعات الخلايا غير المكونة للعظم عن الأنسجة الرخوة المحيطة ، مما يتيح للخلايا المكونة للعظم أن تنشأ من عظم الأم لتسكن الجرح العظمي . أصبحت زيادة استخدام عملية تجديد العظام (GBR) الخيارالرئيسي لتوفير العظام الأمثل لدعم التحام متكاملة زرعة الاسنان مرتبطة بالعظم.واحدة من أهداف GBR هو تشكيل عظام جديدة في مواقع نقص في حجم العظام .هدف آخر هو لعلاج نفاذية وظهور الزرعة الناجم على سطوح العظام التي تمت الزرع عليها وكذلك العيوب المرتبطة بالزرع التزامني .وقد سمح GBR بوضع الترميم في مواقع أكثر مثالية في تجويف الفم ، وبالتالي تحسين الشكل الجمالي والوظيفة.

هدف الدراسة : تحسين حجم عظم الفك (السُمك) الناجم عن استخدام بديل العظام الاصطناعية المغطاة بغشاء الكولاجينالقابل للذوبانالمستخدم في زراعة الأسنان التزامني.

المواد و الطرق : تم إستخدام هذه الدراسة في تدريس طب الأسنان في مستشفى كلية طب الأسنان في جامعة بغداد ل (15) مريض ولديهم 21عملية زرع الأسنان مع دعم عظمي غير كافي لزراعة الأسنان الفورية . تم علاج جميع المرضى في وقت الزرع من قبل باستخدام بديلا العظام الاصطناعية عن طريق غشاء الكولاجين القابل للذوبان . تم فحص جميع المرضى سريريا من قبل (osteometer) جهاز قياس سُمك العظموالرسومات الراديوية (CT)لتقييم عُرض النتوء وإرتفاعه و كثافة العظام .أجريت هذه الدراسة في الفترة من مارس/ اذار 2013 إلى نهاية ديسمبر/ كانون الأول 2013.

النتائج:بينت التجارب السريرية والشعاعية تزايداً في عُرض النتوء بعد 6 أشهر من فترة الشفاء في ثلاثة مستويات : في القمة والمتوسط والذيلي. سريريا, فأن متوسط عرض النتوء قبل الجراحة كان (4.63،3.38 و 5.35) ملم في على التوالي و بعد 6 أشهر أصبح عرض النتوء كافيا لدعم زرع الأسنان بشكل جمالي ووظيفي. قيمة متوسط عرض النتوء بعد العمل الجراحي أصبح (6.958.68،5.10) ملم . و قيمة المعدل قبل الجراحة بالأشعة السينية (3.864.66،2.97ملم واصبحت هناك زيادة هذه القياساتبعد الزرع ،(6.80 ، 7.33 و5.31)ملم في الثلاث مستويات.

كان هناك (7) ذكور من المرضى تتراوح أعمارهم بين (46.67 %) و (8) من المرضى الإناث (53.33 %) وتتراوح أعمارهم بين (20-50) سنة متوسط العمر في مجموعة الذكور (35.43) و في مجموعة الإناث كانت الفئة العمرية (31.88) . لم تكن هنالك فروق بارزة بين زيادة عُرض النتوء المُقاسة سريريا و صورياً (CT) و نوع الجنس والسن.حققت هذه الدراسة نسبة نجاح (95.24) ٪ في (20) عملية زرع الأسنان وفشلت عملية واحدة فقط بنسبة (4.76) ٪ في سن 47 سنة.

الاستنتاج :كان هناك زيادة كبيرة في حجم العظم الفكي الذي زاد في وقت الزرع ليصبح العُرض كافيا لدعم عملية الزرع بصورة جمالية وفعّالة. كما وتكشف هذه الدراسة أنه لم يكن هناك أي تأثير من حيث نوع الجنس والسن على زيادة حجم العظام بعملية توليد العظم بمادة العظم الإصطناعية.