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EFFICACY OF SCREW EXPANSION FOR NARROW ALVEOLAR RIDGES IN DENTAL IMPLANT SURGERY, A CLINICAL STUDY

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Abstract

Post-extraction alveolar ridge resorption is unavoidable phenomenon ending with insufficient ridge width. Bone grafting, osteotome ridge expansion and ridge splitting were used to expand narrow ridges but they are either expensive, associated with higher morbidity or require longer treatment time. Therefore the use of screw expansion was introduced as an option for managing deficient ridge width enhancing ridge density, facilitating immediate implant placement and is not associated with potential complication. The aims were to evaluate of the efficacy of bone screw expanders in widening narrow ridges, measuring bone gain and assessing possible complications.

This clinical prospective study was performed between October 2015 & October 2016. Twenty four patients with 45 potential sites were involved. Preoperative clinical examination and radiographic assessment with OPG were performed for all cases. ITL bone expander kit was used after initial osteotomy to expand the narrow ridges. Osstell ISQ was utilized to measure the primary implant stability. After 16 weeks, patients were recalled again for the second stage surgery and Osstell was used again to measure the secondary stability. Patients then were referred to the prosthetic department for completion of final prosthesis after sufficient time for healing abutments in place.

Twenty four patients were participated with 45 implants inserted. Female to male ratio was 2.4:1 with a mean age of 43.12 year ranging between 18–65 years. The original mean bone width (Mean±SD) prior to expansion was 3.3±0.56 mm & after expansion associated with dental implant insertion was 5.09±1.05 mm and there was statistical significance in possible mean bone gain by 1.79 mm from baseline. The overall survival rate was 91.1% with the anterior parts of both jaws having the highest percentages. Intraoperative complications involved cracks which were observed in 15 sites (39.5%) and cortical malfractures which were seen in 7 sites (15.6%).

In conclusion, screw expansion is an easy solution for expanding narrow ridges with least possible complications and allow for simultaneous implant placement.

Introduction

The revolutionary introduction to the field of dentistry was marked by Branemark, an orthopedic surgeon, in 1952 when brought to the surface the idea of osseointegration. In 1982, Branemark presented his discovery in a professional meeting that titanium can be used to restore missing teeth. In the years following, dental implantation received a wide attention and interests resulted in improvement of human function, smile and psychology. A milestone for novel implant science is that sufficient bone should be available for the placement of dental implant to ensure stability, osseointegration and very importantly the long term success[1]. A 1-1.5mm bone width at least needed to be available around the dental implant taking into account the post operation resorption of the alveolar bone and to withstand occlusal forces applied during function that by their own may enhance the process of resorption[2]. One of major limitation for implant placement is the atrophied ridge where no satisfactory bone is present out there to house implants like in ordinary situation.

In such circumstances alveolar part of the maxilla or mandible which is planned to be operated have to be manipulated in such way that help implant placement with predictable outcome[3]. Marked complications noted with placement in narrow ridges include poor emergence profile, labial dehiscence, and exposure of the implant after slight resorption beside off-set axial forces[4]. It was documented that ridge volume would be lost due to atrophy, trauma or periodontal diseases[5]. Regardless of the reason behind deficient alveolar part of maxilla or mandible, many options were improvised to overcome such obstacles including (without sequence) the use of narrow implant, osteoplasty, osteotomes, ridge splitting (RS), bone augmentation and guided bone regeneration (GBR), horizontal distraction osteogenesis and bone expansion[6]. In addition to their important privilege in clinical implantology, each of the aforementioned procedures has certain disadvantages.

Expanding thin ridges can be performed by especially designed screw shaped bone expander spreaders developed by authors Dr. Strekbein & Dr. Hassenpflug having the advantage of ensuring controlled expansion process, less invasiveness and tolerability. The use of different sizes of these expanders in a sequential manner is the way of enlarging operation[6]. The aims of this research included: evaluation of the amount of possible bone gain in the alveolar ridge width after the use of screw expansion to widen narrow ridges and evaluation of possible complications that may be encountered during expansion process.

Materials and Methods

Twenty four Iraqi patients were recruited from patients pool in dental implant unit, College of Dentistry, University of Baghdad. This clinical prospective study was carried out in the period between October 2015 & October 2016.

Inclusion criteria:

1. Patient's age is recommended to be 18-70 years.
2. Single or multiple edentulous areas in maxilla or mandible of both genders.
3. Alveolar ridge width of about 2.5-4mm.
4. Patients having no history of systemic diseases that may compromise surgical procedure or bone healing capacity (Cushing syndrome, hyperpara-thyroidism, etc..).
5. Healed extraction site of at least 6 months healing period (delayed protocol of dental implant placement).

Exclusion criteria:

1. History of head & neck radiotherapy or history of chemotherapy.
2. Acute or chronic inflammation or any pathology at the planned area of surgery.
3. Patients with limited mouth opening to a degree precludes easy handling and instrumentation (1 finger breadth).
4. Active periodontal disease.
5. Patients confirmed clinically with parafunctional habit.
6. Pregnancy.

Clinical and radiographic examination:

Patients were examined extraorally for any possible pathology in head and neck region, smile line, TMJ and mouth opening. Intraoral examination involved status of available teeth and their periodontal support, inter ridge distance during occlusion and oral hygiene. OPG radiograph were requested for all patients for measurements of the available bone height, condition of the bone for any underlying pathosis and evaluation of the a proximity of adjacent vital structures. Just before surgery, patient's informed consents were signed after the case sheet was filled. Patients were asked to gargle their mouth with chlorhexidine 0.2% for about 1 minute to decrease bacterial load & so reducing risk of contamination.

Circumoral scraping by gauze soaked in chlorhexidine 4% in circular manner passing through nostrils from outer to inner circle. Patients then wrapped with sterile surgical draping and head cap.
Surgical procedure: First stage surgery: Local anesthesia was given as infiltration. Extensive flap design with crestal incision palatally/lingually biased. Bone caliper is applied directly to the exposed alveolar ridge 1mm below the crest and the value was recorded (Fig. 1).

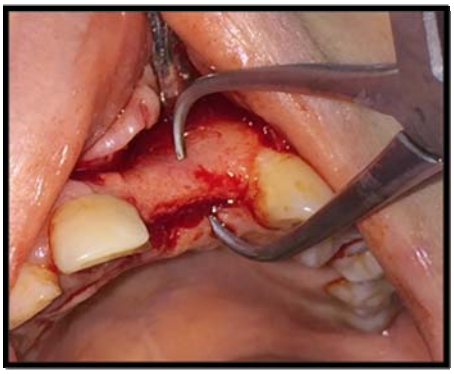

Fig. 1: Bone caliper used with beaks 1mm below alveolar ridge crest in tooth site No. 8.

Vertical cortical furrow was created with disk bur with good cooling, a maneuver when very dense bone created a risk of malfracture of cortex. Pilot drill of ITL (Fig 2 A & B) bone expanders kit (BEK) with a diameter of 1.5 mm was used with angled hand piece at a speed of 600 rpm.

Fig. 2: A. BEK in a sterile pouch, B. BEK containing different sizes of expanders (ITL Dental, USA)

After completion of pilot drilling to the desired length, first screw expander was used which is 2.3 mm diameter either with motorized hand piece at 45 rpm & 35 N cm torque or manually with wrench supplied with this kit(Fig 3).

Fig. 3: First bone expander used manually

For each two spins a waiting time (pause) of 20-30 seconds was compulsory to allow bone to adapt to the applied stress and expand under control. Once significant resistance was encountered, reverse torqueing of the screw expander, unhand for 20 seconds and then reinsertion proceeded under saline irrigation a maneuver that would avoid hesitated expansion that might compromise cortical plate. When the first expander had reached to the desired length, it was left in place for about one minute. The expander then removed and the next one applied in the same manner until reaching the desired diameter capable of housing dental implant of the required dimensions. Dental implants were installed with hand piece at a speed of 35 rpm and torque of 35 Ncm and final seating achieved with manual wrench. The bone caliper applied again after implant instillation to measure the new ridge width either 1mm below the crest if no osteotomy was done or at the level of the crest since 1mm of bone was removed with osteoplasty. Smartpeg was screwed into the fixture body and tightened. Osstell TM ISQ probe was used in mesiodistal and bucolingual/palatal directions without touching the transducer (2-3 mm away) at 90° from both directions, Fig (4 A & B). Displayed values were recorded as a baseline for future follow up.

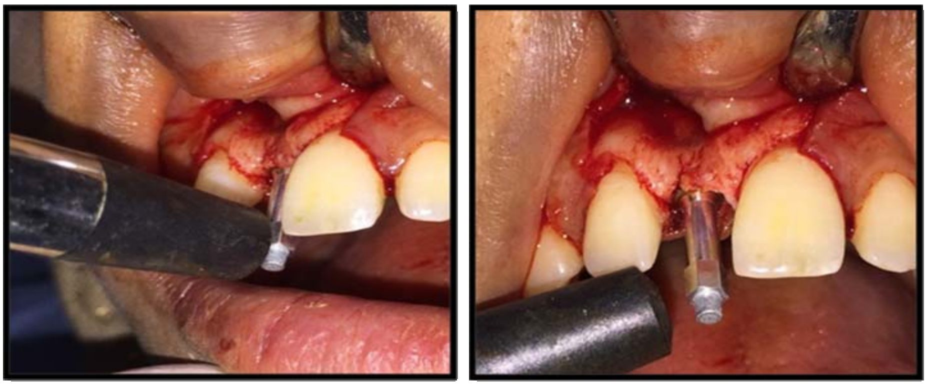

Fig 4: A.Osstell probe applied in buccopalatal direction B.Osstell probe applied in mesiodistal

Second stage surgery:

Sixteen weeks postsurgical healing period, patients returned back to dental implant clinic. All patients were asked for postoperative OPG radiograph. Motorized tissue punch was used after adequate anesthesia. Localization of the implant fixture was depending on dark shadow of the cover screw and radiograph. Smartpeg was again mounted to the fixture and Osstell TM ISQ used to measure the secondary implant stability. After 10 days for healing abutments in place, patients were referred to the prosthetic department for final prosthesis.

Statistical analysis

Paired t test was used to analyzed continuous variables that followed prospectively in time, and when we compare two group at 2 different time periods we used factorial analysis (MNOVA) to see which of them is significantly better, Chi square test used to analyze the differences in distribution between discrete variables, and when the sample size below 20 or 2 or more expected value for 2x2 table presented Fisher exact test used instead. SPSS version 23 software, and Minitab version 17 software package.

Results

Twenty four patients (7 males & 17 females) participated in this study with a 45 dental implants (44% of them in anterior maxilla) were ingrained, 38 implant with SE while 7 with GBR. Mean age 43.12 years (ranging between 18 to 65 years. 57.8% placed in the maxilla & 42.2 % in the mandible. Implant diameter 3.4 was the mostly used (68.9%), 3.8 (24.4%) & 4.3 mm (6.7%). The mostly used implant length was 10mm (40%), 12mm (35.5%), 8mm (17.7%) and 14mm (6.6%). The mean bone width (mean± SD) before expansion was 3.3 ± 0.56 mm while that after expansion with dental implant insertion was 5.09 ± 1.05 mm. There was an increase in bone width in the end of the study by 1.79 mm from baseline and this was statistically highly significant (P value >0.001%)(Fig. 5).

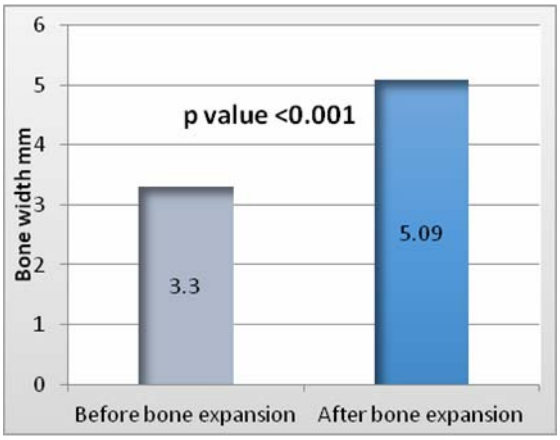

Fig. 5: Bone width changes

Both jaws showed statistically significant bone gain. There was an insignificant increase in the ISQ from primary to secondary stability, (65 ± 16.4 to 67.54 ± 6.4) with p value 0.332. Bone density (D2) was the dominant one (91.1%), D3 (6.7%) & then D1 (2.2%). The overall survival rate was 91.1% and for successful screw expansion cases was 100%, no significant difference in survival rate between different regions of both jaws (p value 0.99). Thirty eight SE cases (84.4%) were successful and only 7 cases (15.6%) marked as failed expansion. No significant differences in the distribution of failed expansion neither between maxilla and mandible (p value 0.99), table I, nor between different regions of both jaws (p value 0.549).

Table I: Descriptive statistics for the survival rate of dental implants

Arch		Implant	Survived	Failed	P value
Maxilla	No.	26	24	2	0.99 (NS)
	%	57.8	92.3%	7.7%	
Mandible	No.	19	17	2	
	%	42.2	89.5%	10.5%	
Total	No.	45	41	4	
	%		91.1	8.9	
Fisher exact test					

Intraoperative complications involved 15 Cracks (39.5%) of implant beds and 7 Cortical malfracture (15.6%) of SE. No significant difference between different densities and cracks (p value 0.258) and malfractures (p value 0.667). No significant difference between mean bone width in positive and negative cases of both cracks and malfracture (table II).

Table II: Comparison of mean bone width with cracks and malfractures

		No. & %	Mean	SD	P value
Crack	Negative	23 (60.52%)	3.41	0.56	0.137 (NS)
	Positive	15 (39.47%)	3.13	0.55	
Cortical malfracture	Negative	38 (84.44%)	3.30	0.56	0.112 (NS)
	Positive	7 (15.55%)	2.93	0.53	
T test					

Discussion

The mostly utilized implant diameter were 3.4 mm (68.9%), 3.8 mm (24.4%). The employment of such diameter is compatible with what mentioned above about the most common involved regions of the jaw which is the anterior maxilla where diameter of 3.4 & 3.8 mm usually placed to allow at least 1 mm of bone around dental implant and these are the suitable diameters for this region functionally and esthetically[7]. In addition the use of screws for expansion may aid in more stress resorption due to compression necrosis[8], so narrower implant help to avoid overstressing of alveolar ridge, since wider implants require more bone expansion with subsequent more compression that may compromise to certain degree the local microcirculation[9]. In regard to implant length, 10 mm implants were mostly introduced in this study (18 fixtures), followed by 12 mm (16 fixtures). These dimensions are close to that used by Chan et al[10] where implants of 10 mm length where used in a study on human cadavers where screw expanders were tested. No other similar studies had taken consideration of implants dimensions in their results to compare with.

In this research there was an increase in the mean ISQ from primary to secondary stability (65±16.4 to 67.54±6.4), however this rise in ISQ is neither significant statistically (p value 0.332) nor clinically since the accepted range for secondary ISQ is between 57-82[11] with a mean of 69 ISQ[12]. Sencimen et al[13] recorded higher ISQ values and from clinical point of view the difference was significant since it falls in various ISQ categorization of which was yellow zone (medium stability) in this research and green zone (high stability) for their study, according to sennerby[14]. The reasons behind higher values may be related to the greater amount of bone available for housing dental implants or could be for the type of surface texture with type of treatment of the dental implants used. In this research, both jaws were involved with a mean bone width of 3.3±0.56 mm & 5.09±1.05 mm before and after expansion respectively with a mean bone gain was 1.79 mm and was statistically significant. This was in harmony with Mazzocco et al[15] who had mean bone gain of 1.5 mm and Chan et al[10)] who had mean bone gain of 1.31mm supporting previous results that screw expansion technique was an efficient procedure to expand narrow ridges. The gradual and controlled use of these expanders proved to have the capacity to prepare osteotomy sites that can't be prepared with conventional way beside improving ridge density[9] especially in posterior maxilla were poor density is expected. Cracks were the most prevalent intraoperative complication associated with SE (39.47%) presented in 15 of 38 successful SE. Such high percentage may be related to a thin buccal cortex with little or no cancellous bone aiding in perfect bone lateralization. Since D2 was the dominant density (91.1%), it was not a convenient parameter to relate it to cracks. Since sample size is somewhat small, distribution of cracks among different jaw regions were not valuable and showed no great difference between them (apart from anterior mandible where only one implant was placed).

Kao & Fiorellini[16] compared ridge expansion with RS on a swine cadavers in a two groups study with total of 18 mandible for each group. Cracks were confirmed in 27.77% in ridge expansion group. Such difference between this study and theirs could be attributed to the nature of sample employed in the two studies and human rather than swine cadaver were included, sample size discrepancy, variation in ridge densities that were not regarded in the study Kao & Fiorelliin[16]. Seven cases (15.55%) of SE had developed malfrcature out of 45. When relating malfracture to bone density, there was no significant effect of density on the malfracture (P value 0.667) occurrence. Inadequate variation in densities available with predominance of D2 may explain such insignificance. Although cortical malfracture reduced with increase in original ridge width, there was no significant difference (p value 0.112) between the mean of original ridge width at which malfractures were positive (2.93 ± 0.53 mm) and negative (3.30 ± 0.56 mm). Kolerman et al[17] conducted a biometric study using osteotomes. Six of 122 cases which accounting for 4.9% had developed malfracture in a ridge width range between 2.5-5 mm. Higher percentage of malfracture were reported in the study might be related to sample size (24 vs 122). A wider range of ridge widths were involved in Kolerman et al [17] study than the present study which also may explain this high percentage. Another explanation is the difference in the nature of the material which is clinical and biometric.

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