

# **RESEARCH ARTICLE**

#### THE EFFECT OF DIFFERENT FLAP TECHNIQUES ON BONE CHANGES IN SPLIT CREST RIDGES WITH SIMULTANEOUS IMPLANT PLACEMENT. A Systematic review

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### Manuscript Info

Abstract

Manuscript History Received: 12 June 2016 Final Accepted: 19 July 2016 Published: August 2016 Key words:- Ridge split, ridge expansion, bone height changes, narrow ridge,split crest.	<ul> <li>Statement of problem:-The maxillary ridge split treatment options, which include different flap techniques with simultaneous implant placement, may help eliminate the current undetermined best choice of treatment plan.</li> <li>Purpose: - The aim of this systematic review was to evaluate outcome of simultaneous implants placement in alveolar ridge split carried out by different flap approaches on marginal bone changes and survival rate.</li> <li>Materials and Methods: - English publications on the subject were searched to select articles up to December 2015. Articles in peerreviewed journals were searched in an electronic database</li> </ul>
	reviewed journals were searched in an electronic database (MEDLINE, Pub- Med and Cochran). Also, a manual search studies on humans was carried out. Two independent reviewers screened 855
	<ul> <li>Result: - 843 articles were excluded on the basis of the title and abstract. Full-text articles were obtained for the 12 selected publications. The 12 full texts were assessed by the two reviewers and 3studies were found fitting for inclusion.</li> <li>Conclusion: - The limited data indicates that the flap design does not affect bone changes and survival rate in ridge split procedure with simultaneous implant placement.</li> </ul>
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#### **Clinical implications:-**

No current consensus has been published on which the more effective flap option in ridge split with simultaneous implant placement. Ridge Split Techniques show no significant difference in bone loss and high survival rates and therefore seems to be a predictable treatment modality for implant placement in narrow alveolar ridges.

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### **Introduction:-**

The limited amount of remaining alveolar bone may compromise proper implant placement and subsequently, the functional and esthetic rehabilitation of the edentulous ridge.<sup>1-7</sup>

A variety of prosthetically-driven bone augmentation techniques for the deficient alveolar bone have been proposed in the literature.<sup>8</sup> The more frequently reported techniques were: (1) guided bone regeneration (GBR)/using particulate bone grafting<sup>9,10</sup>;(2) onlay (veneer) block bone grafting with intraoral donor sites, such as chin, ramus, posterior mandible, and maxillary tuberosity<sup>11,12</sup>;(3) alveolar distraction osteogenesis<sup>13-15</sup> and (4) ridge split.<sup>16-18</sup> Most of these techniques are advocated to improve horizontal bone loss before or simultaneously with dental implant placement. Although these methods are proved to be effective, they require long periods for bone consolidation prior to implant placement with possibility of second morbidity at the donor site.<sup>19,20</sup>

Ridge splitting technique is used for horizontal bone deficiency only. The procedure is carried out by opening and subsequently splitting compromised alveolar ridge with special osteotomes with / without bone substitutes packed between the two split alveolar ridges to avoid the collapse of expanded ridge.<sup>21</sup>Ridge split could be either carried out with a full thickness flap or minimal flap reflection. This technique can be practiced either in single step, which comprises splitting of ridges and simultaneous implants placement, or in two steps, involving ridge splitting and waiting for interval of 4-6 months following the augmentation before implant insertion surgery.<sup>22-24</sup>

The effect of the Alveolar Ridge Split Technique (ARST) with simultaneous implant placement on marginal bone loss is still unclear. Reviewing the literature, **a** paucity of articles was found dealing with the subject and no systematic reviews were detected. Most of the reported literature of this procedure are mainly case reports and case series, neither of which is strong with respect to the hierarchy of evidence.<sup>25, 26</sup>The objective of this systematic review is to fill a gap in knowledge and comprehension of the effects of simultaneous implant placement with different ridge split techniques on marginal bone loss and survival rate of implants. It also, aimed to eliminate errors that were detected in previous studies.

# Material and method:-

The PICO criteria were used, and the target question for specific literature search was outlined (Needleman 2002)<sup>27</sup>; P: patients with horizontal atrophic maxillary alveolar ridges and requiring ARST; I.1: widening of atrophic alveolar ridges using minimum flap techniques (closed ridge split) with simultaneous dental implant placement. I. 2: widening of atrophic alveolar ridges using split thickness flap techniques with simultaneous dental implant placement. C: implant placement with full thickness flap (open flap) for ARST; O: potential effects of flaps design on crestal bone level change, and implant survival rate.

Publications on the subject in English Language only were searched up to December 2015. A systematic search was performed in two databases servers (MEDLINE, Pub- Med and Cochrane) for articles published in peer reviewed journals and performed on humans.

The key words used were(Dental implant) or (Dental implants) or (Implant) or (Implant placement) or (Implantation) or (Dental Implantology), and (Narrow ridges) or (Thin ridge and Horizontal Ridge augmentation) or (Ridge alternation) or (Ridge split) or (ridge spliting) or (Split crest techniques) or (Alveolar ridge split) or (Alveolar ridge split) or (Ridge split techniques) or (Ridge spliting) or (Split crest) or (Ridge spliting technique)

A manual search of relevant peer-reviewed researches published until December 2015 was performed in the following journals: Clinical Oral Implants Research, International Journal of Periodontics and Restorative Dentistry, Journal of Periodontology, Journal of Clinical Periodontology and International Journal of Oral and Maxillofacial Implants, Journal of Prosthetic Dentistry, Journal of Prosthodontics, Journal of Oral Rehabilitations. Moreover, the bibliographies of the selected articles and relevant reviews were thoroughly examined.

### Inclusion Criteria:-

Randomized Controlled Trials (RCT) or NON Randomized Controlled Trials (NRCT) on ridge splitting, immediate implant insertion, human study, and the primary outcomes were bone resorption, and Secondary outcomes were failure and survival rate of implants.

#### **Exclusion Criteria:-**

Systematic reviews, case series and reports, Cohort, ridge splitting in lower arch only (without maxilla), two staged ridge splitting, and ridge splitting without immediate implantation. Screening process showed in Prisma chart.<sup>28</sup> (Figure 1)



#### Validity assessment:-

Two independent reviewers (M.D and H.Ch.) screened 855articles from the electronic and manual search for possible inclusions in this review. A consensus on the studies to be selected was achieved after intensive examination; 843 articles were excluded on the basis of removing duplicates, screening for relevance on title then abstract then full text article. Kappa Score for the selection of the articles was 0.89. Full-text articles were obtained for the 12 selected articles. The 12 full texts were evaluated by the two independent reviewers. Three studies were found to meet the requirements for inclusion, whereas 9 studies were excluded (Fig.1)

The reasons for not including the papers were that: six was found to be case series; one was case report, one retrospective study and one narrative review. (Table 1)In the selected studies, the type and possibility of bias were performed by two independent authors ((M.D and H.Ch.) as part of collecting data process. Variations and disagreements between the two examiners were agreed upon by discussions and consensus. Bone loss, and survival rate and failure were searched in all articles included.

### **Results:-**

Three articles were included in this study. They are mentioned in (Table 2).

Authors	Article name	Reason for
and date		exclude
Oikarinen	Augmentation of the narrow traumatized anterior alveolar ridge to facilitate	Narrative review
$2002^{29}$	dental implant placement	
Simon	Jawbone enlargement using immediate implant placement associated with	
1992 <sup>30</sup>	a split-crest technique and guided tissue regeneration	Case series
Blus		Case series
2015 31	Split-crest and immediate implant placement with ultra-sonic bone	
	surgery: a 3-year life-table analysis with 230 treated sites	
Scipioni	Morphogenic bone splitting: description of an original technique and its	Case series
$2008^{-32}$	application in esthetically significant areas. Case series	

Table 1:- showing excluded articles.

Blus	Split-crest and immediate implant placement	Case series
2010 <sup>33</sup>	with ultrasonic bone surgery (piezosurgery):	
	3-year follow-up of 180 treated implant sites	
Gonzalez		Case series
Garcia	Alveolar split osteotomy for the treatment of the severe narrow ridge maxillary	
2010 <sup>34</sup>	atrophy a modified technique	
Sammartino	The Platform Switching Approach to Optimize Split	Case report
$2014^{35}$	Crest Technique	
Garcez-	Long-term outcomes from implants installed by using split-crest technique	Case series
Filho	in posterior maxillae: 10 years follow-up	
2013 <sup>36</sup>		
Danza	Comparison Between Implants Inserted Into Piezo Split and Unsplit Alveolar	Retrospectivestudy
$2015^{37}$	Crests	-

**Table 2:-** showing the included article.

Authors and date	Title					
Mounir et.al	Assessment of marginal bone loss using full thickness versus partial thickness flaps for					
$2014^{39}$	alveolar ridge splitting and immediate implant placement in the anterior maxilla					
Abuelroos	Management of Severely Resorbed Ridge Using Ridge Splitting Techniques with	RCT				
2009 <sup>40</sup> simultaneous Implantation						
Jensen 2009 <sup>18</sup> Marginal Bone Stability Using 3 Different Flap Approaches for Alveolar Split Expansi		RCT				
	for Dental Implants—A 1-Year Clinical Study					

Risk of bias (quality) assessment(Table 3): The type of the included studies was examined by the Cochrane Collaboration tool for assessing the risk of bias in systematic reviews of interventions, which covers the process of sequence generation, allocation concealment, blinding, incomplete outcome data (like attrition bias), and selective outcome reporting (detecting bias), as well as the risk of other potential sources of bias (other bias).<sup>38</sup> The original study investigators were contacted for more information. These judgments were made by the two review authors who applied the criteria for evaluating the risk of bias (Table 8.5.c in the Cochrane handbook Higgins 2011).<sup>38</sup>

Table 3:- showing risk of bias.

Article	Sequence	Allocation	Blinding	Reporting	Incomplete	Risk of
	generation	concealment		bias	outcome data	bias
	(Randomization)					
Domains						
Mounir et al 2014	Yes was done	Yes was done	Double	No	No	Low
39	(low risk)	(low risk)	blinded	(low risk)	(low risk)	
			(low risk)			
Abuelroos.et al	Not done	Not done	Not done	NO	No	High
$2009^{40}$	(high risk)	(high risk)	(high risk)	(low risk)	(low risk)	
Jensen et al 2009	Not done	Not done	Not done	No	No	High
18	(high risk)	(high risk)	(high risk)	(low risk)	(low risk)	

According to defined criteria, in 3 out of 12 publications examined, the estimated risk of bias was judged as low in one RCT and high in two articles

According to Cochrane assessment tool<sup>38</sup>; used for articles assessment in this review. If there was one domain at high or ill-defined risk of bias, the whole articles considered as high risk. Consequently, two of the included studies are at high risk of bias and one study showed low risk of bias. Specifically, in detecting selection bias, only one

study (Mounir et al 2014<sup>39</sup>) reveals the low risk of bias while the other studies revealed high risk (Abuelroos .et al 2009<sup>40</sup> and Jensen et al 2009<sup>18</sup>). Whereas, for the allocation concealment domain only one study (Mounir et al 2014<sup>39</sup>) reveals the low risk of bias while the remaining studies revealed high risk (Abuelroos .et al 2009<sup>40</sup> and Jensen et al 2009<sup>18</sup> for blinding of patients (performance bias) all studies were at high risk of bias except (Mounir et al 2014<sup>38</sup>).Regarding reporting bias domain all 3 studies (Mounir et al 2014<sup>39</sup>;Abuelroos .et al 2009<sup>40</sup> and Jensen et al 2009<sup>18</sup>) showed low risk of bias. Finally, both attrition bias, reporting bias, and other biases were not reported in all studies.All these assessments were presented in risk of bias summary Table 4 for individual studies.

### Characteristics of trial setting and investigators (Table 4, Table 5):-

The 3 included trials were a parallel group study design.

**Table 4:-** showing included article characteristics.

	Study design	Number of	MEAN	Number	Site	Bone	Funding
Article		patient	Age	of		graft	
				implant			
Mounir et.al 2014 <sup>39</sup>	RCT	22	38	43	Maxilla	Yes	Self-funding
		9 F					
		13 M					
Abuelroo.etal	RCT	44 M	40	40	maxilla	no	Self- funding
$2009^{40}$							
Jensen et al 2009 <sup>18</sup>	RCT	40	NO	81	Maxilla &	Yes	Not
					mandible		mentioned

### Table 5:- showing included article characteristics

Article	Type of comparators	Type of intervention	Out come	Follow up	Methods
Mounir et al 2014 <sup>39</sup>	Split thickness flap	full thickness flap	Marginal bone loss	6 month	СВСТ
Abuelroos et al $2009^{40}$	Open ridge split technique	Close ridge split technique	Bone resorption	18 month	СТ
Jensen et al 2009 <sup>18</sup>	Split thickness flap	Full thickness flap versus minimum flap reflection	Marginal bone stability &Survival rate	1 year	blunt periodontal probe <sub>+</sub> explorer trans gingival

### Primary outcome :Crestal bone level changes (CBL) over time Table (6):

The bone changes reported were (1) Bone width gain, (2) Mesio-distal height, (3) Buccal/labial plate of bone and (4) Palatal plate of bone. In all four publications ,the height of the crestal bone level around the implants (CBL) at the mesial and distal implant aspects were derived from different methods (CBCT, CT, standardized 2D Periapical x-rays, orthopantomograms, and computed tomograms, and probing to measure CBL) and followed-up for different time intervals.

In Mounir et al 2014<sup>39</sup> article, there was a significant difference in bone height after 6 months in both groups (FTF,PTF), the mean marginal bone loss in Group I (Full Thickness Flap ridge splitting ) was 2.29 mm (15.36% bone loss), while in Group II (Partial Thickness Flap ridge splitting), it was 0.71 mm (5.89% bone loss) in labial plate, The mean marginal bone loss in Group I was 2.48 mm (16.84% bone loss) and that in Group II was 1.14 mm (8.99% bone loss) in the palatal. Mesiodistal mean Marginal Bone Loss (MBL) in group I was 1.83 mm (12.21%), while that in Group II was 1.15 mm (8.77%). The percentage MBL in the group II was significantly less than that of Group I in the three surfaces. The partial thickness flap used in the Group II showed less bone resorption by 9.5% in the labial bone plate, 7.9% in the palatal bone plate, and 3.5% in the mesiodistal bone plate.

In Abuelroos, et al 2009<sup>40</sup> article, Although, the non-reflected muco-periosteal flap maintain good blood supply of buccal cortex in Group I (closed ridge splitting), a significant differences in buccal bone changes was reported. Bone loss both vertically and horizontally during the follow up periods in this group was attributed to the blind ridge splitting with closed technique.

The results of this study showed that marginal bone loss was  $0.190 \pm 0.04$  in height. And  $0.184\pm0.04$  in width in Group 1 and  $0.249\pm0.06$  in height and  $0.239 \pm0.05$  in width in Group II after 18 month follow up. However, the results showed no significant difference between the two evaluated groups .Jensen et al  $2009^{18}$ ; indicated that the most reported complication with alveolar split grafting was resorption of buccal plate of bone and associated gingival recession. This occurred in 14.7 % during the study period, with at least 2mm of bone height lost for all techniques combined, most significantly, bone loss of 2 mm or more occur in 10 of the 12 full thickness flap sites, in one osteogenital flap (minimum flap thickness) site and in two partial thickness flap sites. Over all, the osteoperiosteal flap and partial thickness flap designs where the most stable at up to one year follow-up after augmentation.

Article	Intervention	Follow	Bone width	Mesio-distal		Buccal		Palatal	Palatal	
		up (Month)	Gain	Mean mm	Percentage change%	MEAN mm	Percentage change%	MEAN	Percentage change%	
Mounir et al 2014 <sup>39</sup>	Full Thickness Flap (FTF)	6	NOT MENTIONED	1.83	12.21	2.29	15.36	2.48	16.84	
	Partial Thickness Flap (PTF)		NOT MENTIONED	1.15	8.77	0.71	5.89	1.14	8.99	
Abuelroos.et al 2009 <sup>40</sup>	Full Thickness Flap (FTF) Minimum Flap (closed	18	0.006	NOT MENT	IONED	0.006±0.0	01 NOT MENTIONED 05 NOT	NOT MI	ENTIONED	
Jensen et al 2009 <sup>18</sup>	ridge split) Full Thickness Flap (FTF) Partial Thickness Flap (PTF) Minimum Flap (closed ridge split)	12	4.13 ±3.13 3.44 ±1.44 3.5	NOT MENT	IONED	At Least 2mm WITH 14.7%	MENTIONED 10 cases 2 cases 1 cases	NOT MI	ENTIONED	

**Table 6:-** showing marginal bone resorption.

**Secondary outcome: Survival rates** of implants placed in the same time with ARST carried out with different flap approaches are shown in (Table 7, Table 8). All 4 human studies showed implant survival rates, ranging between 94% and 100%. In all studies, the baseline for the calculation of survival rates was the time of surgery. The observation periods ranged between 6 months and 18 months.

Article	Intervention	No. Of failure implant	No of failed implant	Survival rate%	Lower limit	Upper limit
Mounir et al 2014 <sup>39</sup>	Both group	43	0	100	Non	Non
Abuelroos. et al 2009 <sup>40</sup>	Both group	40	0	100	Non	Non
Jensen et al 2009 <sup>18</sup>	Full Thickness Flap (FTF)		1 of12	94.4	69.3	99.2
	Partial Thickness Flap (PTF)	81	2 of 58	93.5	81.2	99.2
	Minimum Flap (closed ridge split)		1of 11	92.5	NOT MENTIONED	NOT MENTIONED

**Table 7:-** showing Survival rate.

Table 8:- showing intra and postoperative complication.

Article	Intervention	Recession in mm	Number of implant with
			recession
Mounir	Both group	Non	Non
et al 2014 39			
Abuelroos.	Both group	Non	Non
et al 2009 <sup>40</sup>			
Jensen	Full Thickness Flap (FTF)	2 to 3 mm	10/12
et al 2009 <sup>18</sup>	Partial Thickness Flap (PTF)	2mm	8/58
	Minimum Flap (closed ridge	2 mm	1/11
	split )		

In Mounir et al  $2014^{39}$  none of the Forty Three implants placed reported any complications. In Abuelroos .et al  $2009^{40}$ , none of the forty implants placed reported any complications. In Jensen et al  $2009^{18}$ , a total of 81 implants were inserted, 4of which lost osseointegration during study period. Two implants were lost from the partial-thickness flap group .one of 12 from the full-thickness group, and 1 of 11 from the osteoperiostum flap group. The implant success rate reported in this study was 92.5 % for the osteoperiostal flaps, up to 93.3% for the partial thickness flaps, and 94.4% for the full thickness flap. Only one implant was lost in split crest<sup>18</sup>

The outcome of this systematic review is in agreement with other previous and longitudinal studies.<sup>41-43</sup> many other articles presented the precautions that should be applied in ridge split surgeries.<sup>44-47</sup>

# **Discussion:-**

This systematic review aimed to emphasis, whether the type of flap in ridge split techniques with simultaneous implant placement can affect the bone changes? Alveolar split expansion is an excellent approach for regaining alveolar ridge width. In this procedure, bone fragments dislodgment or flap detachment of the out-fractured plate, should be avoided. Bone devitalization and subsequent remodeling could occur as a consequence. When implants are placed simultaneously, primary fixation of the implant must be obtained by apical insertion of the implant, otherwise osseointegration will be jeopardized. The partial-thickness flap design and/or osteoperiosteal flap with minimal flap reflection at the crest were advocated to help maintain bone vitality, as well as alveolar width stability. Splitting of a thin buccal plate in a narrow ridge crest of 3 mm or less that becomes separated from both the buccal and the endosteal blood supply will lead to severe buccal bone resorption even if bone is grafted.<sup>41</sup>

The development of osseointegration is not an accurate measure for evaluating split bone technique success because osseointegration is not differentially influenced by the flap or grafting approach as long as primary implant fixation occurs. Therefore, the method to ascertain alveolar width expansion success is not only by implant success, but also,

by bone stability.<sup>40, 41.</sup> Of the included studies, the possible risk of bias was made by two independent reviewers, using Cochrane tool for risk of bias assessment that is recognized as one of the accurate research tools applied nowadays by many authors and scientific associations.<sup>38</sup>In contrast to previous systematic reviews on ridge split studies which include prospective and retrospective studies, case report case series. The included articles in this systematic review were only RCTs. The hierarchy of the strength of evidence for decision-making includes ranking RCTs on top, then systematic reviews of these RCTs, all the way down to unsystematic clinical observations.<sup>26</sup>

The peri-implant crestal bone level changes (CBL) at the buccal aspects are more important than those observed at mesial and distal sites. Bone mapping at three different time intervals were used in one human study to assess buccal bone changes.<sup>42</sup> These measurements, indicated that in the buccal compared with the mesial–distal aspects, a slightly more pronounced bone resorption can be expected. These findings are supported by animal studies, in which the buccal bone loss during post-operative period were determined: The vertical bone loss reported was more evident in the bucco-lingual plane (1.12 ± 0.35 mm) than mesio-distally (0.49± 0.22 mm), but the difference was not evaluated statistically.<sup>44</sup>

Many authors advocated that the periosteum should not detach from the labial plate to maintain the blood supply and to allow quick healing of bone. Another function of periosteum is evident in containing the fractures that might happen during the splitting procedure and prevent any cracked segment from dislodging while their blood supply is maintained.<sup>44, 45</sup>

Generally, the partial thickness flap reported in the selected articles, showed less bone resorption than that recorded with full thickness flap. Sub-periosteal reflection at the future sites of the bony cuts (tunneling) was a modification of the split thickness flap reflection. In this technique, the periosteum is left intact in the remaining plate of bone. Some clinicians prefer the splitting technique and delay implant placement They recommend that a full thickness flap is reflected before the corticotomies (at the first stage surgery) and then a partial thickness flap is performed during the second stage surgery for implant placement in order to minimize the bone loss.<sup>46, 47</sup>In this technique enough inter-cortical gap was provided, it decreases the possibility of necrosis of the outer cortex, and provides a box to contain bone graftingparticulates.<sup>36</sup>

Jansen et al 2009<sup>18</sup>; evaluated 3 flap approaches for alveolar widening by crest splitting with simultaneous implant placement. They concluded that the 3 flaps had maintained increased alveolar width after 1 year. However, the article reported that most full flap alveolar split cases showed facial bone loss and gingival retraction. The osteoperiosteal flaps (book flap) and partial-thickness flaps showed consistent buccal bone changes patterns.

The limitations of this systematic review including: two of the included studies were at high risk of bias and one was low risk, the overall patient number in the included studies was relatively small to indicate the actual effect of the different treatment modalities. Another possible limitation is the inclusion of only English language published articles, in which, a source of bias could arise. Finally, interpretation the results obtained from this systematic review must be carried out with caution as two of the overall included studies showed high risk of bias.

The authors attempted in this systematic review to reach sound evidence by including only RCTs, In addition, some of the previous systematic reviews did not include RCTs that compared different treatment modalities.

# **Conclusions:-**

Alveolar ridge splitting (either by Full Thickness Flap (FTF), Partial Thickness Flap (PTF), or Minimum Flap (closed ridge split) approaches might be considered a predictable approach to place implants simultaneously at narrow alveolar ridge. Ridge split demonstrates adequate horizontal bone gain, minimal marginal bone loss, implant primary stability, a high implant survival rate, and minimal intra and postoperative complications.

No significant difference was detected between different ridge split techniques (Full Thickness Flap (FTF), Partial Thickness Flap (PTF), and Minimum Flap (closed ridge split) on marginal bone loss and survival rates.

# **Research Implications:-**

More well-designed, longitudinal randomized control studies are required to understand the effect of flap design and immediate implant placement on marginal bone resorption in ridge split done in maxilla, and to quantify bone changes, especially at buccal sites.

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