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TATUM'S OSTEOTOME SINUS LIFT PROCEDURE VS HYDRAULIC SINUS LIFT PROCEDURE FOR DENTAL IMPLANT PLACEMENT

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ABSTRACT

AIM & OBJECTIVES: To evaluate and compare the stability of the implant**,** Infection, Sinus membrane perforation and the height gained by augmentation procedure, BIC ratio and ISQ values in Tatum's osteotome sinus lift and hydraulic sinus lift procedure.

MATERIAL & METHOD: We conducted a randomized single centre study on 20 sinus lift procedure for implants placement. Clinical and radiographic comparison done on the bases of soft tissue inflammation, Infection, clinical mobility, sinus membrane perforation, RFA, Pain, Gain in bone height and bone implant contact ratio.

RESULTS: **N**o significant difference of soft tissue inflammation between two groups. Infection was present in both group at end of 1 month but less in Hydraulic group compare to other. Clinical mobility and sinus membrane perforation was found to be absent in both the groups. Resonance frequency was significantly higher among the patients of hydraulic group comparatively other on several intervals.

CONCLUSION: **S**inus lift with hydraulic pressure has provided a viable restorative solution to edentulous areas especially in a compromised or insufficient alveolar bone volume in areas like posterior maxilla and results are highly predictable with low morbidity; shorten the surgery duration and in turn reducing the cost of treatment comparatively others one.

INTRODUCTION

Implant dentistry has become an excellent treatment modality since its inception into the modern era of dentistry. It not only allows for a conservative and esthetic alternative to treating partial edentulism, but also provides a stable foundation for treating complete edentulism. Dental implants are a viable treatment option when there is sufficient quantity and quality of bone. However, when patients present with deficient alveolar ridges,implant placement is so difficult. This problem is especially magnified in the posterior maxilla where ridge resorption and sinus pneumatization, compounded with a poor quality of bone. The technique of sinus floor elevation has expanded prosthetic options by enabling the placement of additional implant support in maxillary segments with atrophic ridges and pneumatized sinuses. Maxillary sinus floor elevation was initially was so difficult approach to surgeon but now this is so easy and adoptable by so many authors. Present study attempts to compare the efficacy of both Tatum's osteotome sinus lift procedure and Hydraulic sinus lift procedure for dental implant placement in terms of initial and final implant stability and the gain in bone height.

AIM & OBJECTIVES: To clinically and radio-graphically evaluate; Stability of the implant**,** Infection, Sinus membrane perforation and the height gained by augmentation procedure, BIC ratio and ISQ values.

MATERIALS AND METHOD A prospective, randomized, single centre study (Dept of oral and maxillofacial surgery, BBD dental college Lucknow) was performed among patients with at least one or more missing teeth in posterior maxillary arch. 20 Patients were selected from departmental OPD with seeking of replacement of missing tooth/teeth divided into two groups, group 1 Osteotome group (n=10) in which placement of dental implants with Tatum's osteotome sinus lift procedure and another group 2, Hydraulic group (n=10) in which placement of dental implants with Hydraulic sinus lift procedure. In our study those patients considered whose suffering from partially edentulous jaws with a unilateral or bilateral loss of teeth in the maxillary posterior region. Post procedure clinical parametric assessment done on the bases of Stability of the implant with resonance frequency analysis by intra-oral peri-apical radiograph and evaluate clinically. After 7th day, 1 month, 3 months evaluate infection, Pain, Inflammation and sinus membrane perforation. CBCTs were performed after 6 months of placement of implants to calculate the bone height gained by augmentation procedure, BIC ratio and Stability of the implant with resonance frequency analysis (RFA) after 6 months.

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RESULTS AND OBSERVATIONS: The Chi-square and Unpaired t-test was used to compare continuous variables between the groups at follow-ups. The Paired t-test was used for intra group comparisons. The p-value<0.05 was considered significant. All the analysis was carried out on SPSS 16.0 version (Chicago, Inc., USA). A total of 10 patients were included in each group.

Table 1: Comparison of clinical mobility and perforation of sinus membrane between the groups

Comparison of clinical mobility between the groups						Comparison of Perforation of sinus membrane between the groups					
Clinical mobility	Target group (n=10)		Control group (n=10)		P VALUE	Clinical mobility	Target group (n=10)		Control group (n=10)		P VALUE
	No.	%	No.	%	NA		No.	%	No.	%	NA
Present	0	0.0	0	0.0		Present	0	0.0	0	0.0	
Absent	10	100.0	10	100.0		Absent	10	100.0	10	100.0	

[1]Chi-square test, NA-Not applicable as all absent in both the groups

Table-1 shows the comparison of clinical mobility and perforation of sinus membrane between the groups. Clinical mobility and perforation was found to be absent in all the patients in both the groups.

Table-2: Comparison of Resonance frequency between the groups

Groups	Resonance frequency (Mean±SD)
Target group	68.20±2.04
Control group	73.30±3.68
p-value[1]	0.001*

Table-2 shows the comparison of resonance frequency between the groups. Resonance frequency was significantly (p=0.001) lower among the patients of Target group (68.20±2.04) compared to Control group (73.30±3.68).

Table-3: Comparison of pain score between the groups at follow-ups

Time periods	Target group (n=10)	Control group (n=10)	p-value[1]
1 week	3.50±1.43	1.90±1.10	0.01*
1 month	1.40±1.17	0.90±0.73	0.26
3 months	0.40±0.51	0.20±0.42	0.35

[1]Unpaired t-test, *Significant

Table-3 shows the comparison of pain score between the groups at follow-ups. Pain score was significantly lower among the patients of Target group (3.50±1.43) compared to Control group (1.90±1.10) at 1 week. There was no significant (p>0.05) difference in pain score between the groups at 1 month and 3 months.

Table-4: Comparison of infection and soft tissue dehiscence between the groups at follow-ups

Time period	INFECTION					SOFT TISSUE DEHISCENCE				
	Target group (n=10)		Control group (n=10)		p-value[1]	Target group (n=10)		Control group (n=10)		p-value[1]
	No.	%	No.	%		No.	%	No.	%	
1 week										
Present	2	20.0	2	20.0	1.00	3	30.0	1	10.0	0.26
Absent	8	80.0	8	80.0		7	70.0	9	90.0	
1 month										
Present	0	0.0	1	10.0	0.30	0	0.0	2	20.0	0.13
Absent	10	100.0	9	90.0		10	100.0	8	80.0	
3 months										
Present	1	10.0	1	10.0	1.00	0	0.0	1	10.0	0.30
Absent	9	90.0	9	90.0		10	100.0	9	90.0	

Table-4 & Fig. 1 shows the comparison of infection between the groups at follow-ups. Infection was present in 20% patients in both Target group and Control group at 1 week. The infection became nil in Target group at 1 month and was in 10% patients of Control group at 1 month. There was no significant (p>0.05) difference in infection between the groups at all the follow-ups also shows in table 4 and Fig: 2 the comparison of soft tissue dehiscence between the groups at follow-ups. Soft tissue dehiscence was present in 30% patients in Target group and in 10% of Control group at 1 week. The soft tissue dehiscence became nil in Target group at 1 month & 3 months and was in 20% patients of Control group at 1 month. There was no significant (p>0.05) difference in soft tissue dehiscence between the groups at all the follow-ups.

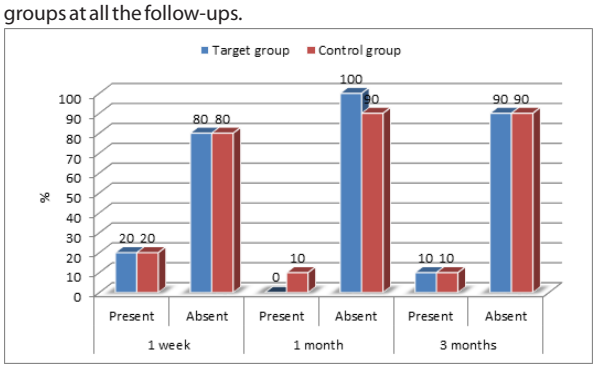

Fig. 1: Comparison of infection between the groups at follow-ups

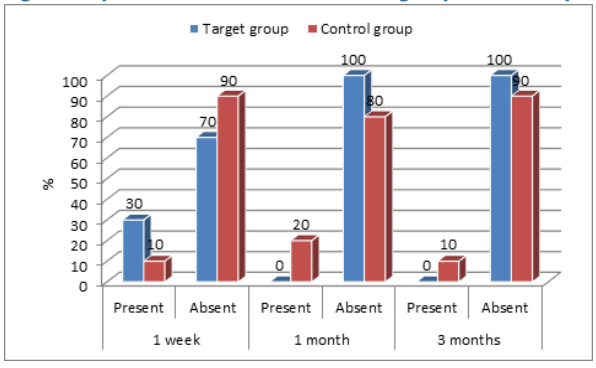

Fig. 2: Comparison of soft tissue dehiscence between the groups at follow-ups

Table-5: Comparison of sinus membrane perforation between the groups at follow-ups

Time period	Target group (n=10)		Control group (n=10)		p-value[1]
	No.	%	No.	%	
1 week					
Present	0	0.0	0	0.0	NA
Absent	10	100.0	10	100.0	
1 month					
Present	0	0.0	0	0.0	NA
Absent	10	100.0	10	100.0	
3 months					
Present	0	0.0	0	0.0	NA
Absent	10	100.0	10	100.0	

[1]Chi-square test, NA-Not applicable as all absent in both the groups

Table-5 & Fig. 3 shows the comparison of sinus membrane perforation between the groups at follow-ups. Sinus membrane perforation was absent among the patients in both the groups at all the follow-ups.

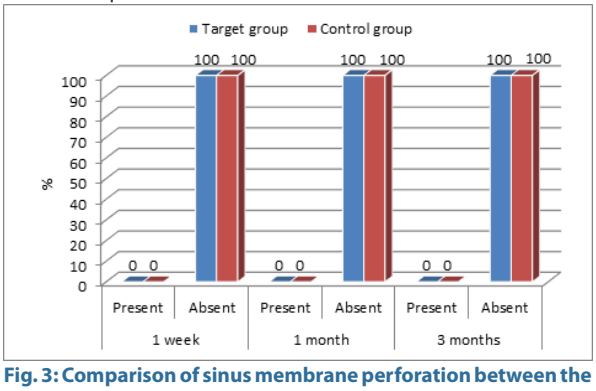

Fig. 3: Comparison of sinus membrane perforation between the groups at follow-ups

Table-6: Comparison of CBCT (%) after 3 months between the groups

Groups	CBCT (%) (Mean±SD)
Target group	87.09±2.89
Control group	89.08±2.64
p-value[1]	0.12

[1]Unpaired t-test

Table-6 shows the comparison of CBCT between the groups at 3 months. CBCT was insignificantly lower (p>0.05) lower among the patients of Target group (87.09±2.89) than Control group (89.08±2.64 after 3 months.

Table-7: Intra group Comparison of pain score between the groups

Time period	Pain score			
	Target group		Control group	
	Mean change	p-value[1]	Mean change	p-value[1]
1 week to 1 month	2.10±1.59	0.002*	1.00±0.94	0.008*
1 week to 3 month	3.10±1.66	0.0001*	1.70±1.16	0.001
1 month to 3 month	1.00±0.94	0.008*	0.70±0.67	0.01*

1 month to 3 month1.00±0.940.008*0.70±0.670.01*[1]Paired t-test, *Significant

Table-7 & Fig. 4 shows the intra group comparison of pain score from 1 week to 1 month and 3 months. There significant (p<0.05) mean change in pain score in both the groups. However, mean change in pian score was higher in Target group compared to Control group.

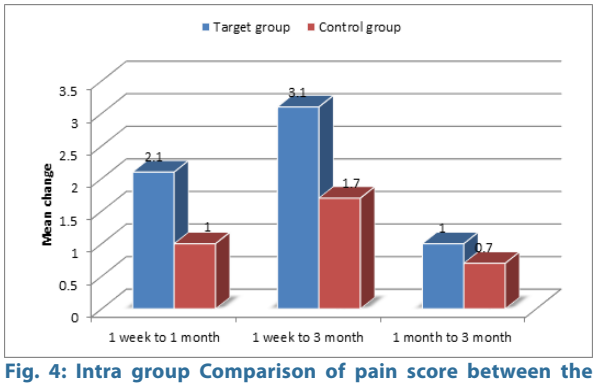

Fig. 4: Intra group Comparison of pain score between the groups

Table-8: Comparison of implant contact ratio (%) and gain in bone height after 3 months between the groups between the groups

Groups	Implant contact ratio (%) (Mean±SD)	Gain in bone height (Mean±SD)
Target group	78.46±27.71	3.00±1.26
Control group	89.08±2.64	4.85±0.81
p-value[1]	0.24	0.001*

[1]Unpaired t-test

Table-8 shows the comparison of implant contact ratio between the groups at 3 months. Implant contact ratio was insignificantly lower (p>0.05) lower among the patients of Target group (78.46±27.71) than Control group (89.08±2.64 after 3 months also shows the comparison of gain in bone height between the groups at 3 months. Gain in bone height was significantly lower (p=0.001) lower among the patients of Target group (3.00±1.26) than Control group (4.85±0.81) after 3 months.

DISCUSSION & CONCLUSION

The primary outcome measures of the study were Intra operative stability post operative soft tissue inflammation, Pain score, Implant mobility, infection, RFA and sinus membrane perforation. The secondary outcome measures of the study were CBCT analysis to assess Bone Implant Contact (BIC) ratio and gain in bone height at after 6 month. Randomized study was done in which the basic characteristics such as available bone height and width were found similar ,but the cases for hydraulic group were having significantly sub optimal bone height (5.46±0.0.43) as compared to osteotome group (7.05±0.811).

The clinical mobility was absent in both the groups at every follow up. We could achieve this because of a strict surgical protocol followed ie; in soft bone and in fresh extraction sockets, implants were placed in underprepared osteotomies. It was possible to achieve implant primary stability even when the available bone height was limited down to 5 mm. Expansion-osteotomes were used instead of drills, to avoid ovalization of the osteotomy site and condense the surrounding bone. Immediate postoperative RFA values were found to be higher in osteotome group (60.30±1.33) than in hydraulic group (58.30±1.15) .It can be attributed to the average initial available bone to place the implant in osteotome group which was significantly more than in hydraulic group and also to the peripheral bone compaction in osteotome group.

Huang HL et al 2011,[4] to maximize initial stability recommended that the recipient bed should be prepared in a slightly smaller size than the implant diameter; at the same time, the use of a fixture with specific microscopical features may be helpful. In our present study, a strict surgical protocol has been followed: in soft bone (types III and IV) and in fresh extraction sockets, implants were placed in underprepared osteotomies. In addition, the threads of the implant used in this study were designed to provide high insertion torque, by increasing their dimensions toward the coronal end of the implant. This specific macro-topographical feature may allow for axial and radial bone compression during implant insertion, and it may be particularly useful in areas of poor bone quality, providing the increased primary stability that is necessary for immediate loading.

The load-free healing period of 3 to 6 months is believed necessary to allow the implant to osseointegrate and prevent formation of connective tissue interface between implant and bone. The implant-connective tissue interface at the collar of implant is important to support the epithelium and block apical migration **(Bori, 1989)**[5], and associated with the implant failure **(El Askary et al., 1999)**[6]. The immediate loading may interrupt the formation of implant-connective tissue interface due to the stress of crown **(Ding et al., 2009)**[7], which may be the main reason resulting the implant mobility.

The most common complication of sinus augmentation is perforation of the Schneiderian membrane. The importance of sinus membrane integrity is warranted to confine the particulate graft and prevent infection for overall graft and implant success. [8] There are many options for treating perforation of the Schneiderian membrane. Suggested surgical techniques to overcome these perforations include suturing, using fibrin adhesive, and over lapping with a resorbable collagen membrane[9]. Internal sinus lift procedure has the advantage of the protection of the intra-osseous vessels in the maxilla and less intra-operative and postoperative morbidity and seems to be a less invasive method with minimal risk of sinus membrane perforation.

In our study Sinus membrane perforation was absent in both group which could be attributed to the careful examination performed to ensure membrane integrity and standardized clinic protocol. **J.Philip. et al in 2013**[10]**,** found perforation rates for indirect sinus floor augmentations usually vary between 0% and 44%. In reality, microscopic tears are, in many instances, impossible to diagnose and therefore their incidence frequency is often underestimated. Some authors explicitly state that small perforations might not have been detected, which means that the perforation rates reported in their studies would be too low. **leon chen &Jennifer cha in 2005**[11]**,**Using special sinus burs and condensers in the hydraulic condensing technique can improve the internal crestal (osteotome)

approach because the instruments provide a greater margin of tactile control and a more straightforward method for placing implants in deficient maxillary ridges. Hydraulic sinus condensing, on the other hand, relies on the gentler tapping of a rotating sinus bur to create a tiny hole through which hydraulic pressure can be introduced. This allows us not only to avoid lacerations, but to place implants even when less than 1 mm of cortical bone is present.

It is a non-invasive diagnostic method that measures implant stability and bone density at various time points using vibration and structural principle analysis[12]. Resonance frequency between 3.5 KHz and 8.5 KHz formed from the magnetic field is converted into ISQ values. It has a magnetic peg which is fixed to the implant fixture or abutment by a screw below. When magnetic resonance frequency is released from the probe, the magnetic peg is activated. The activated peg starts to vibrate, and the magnet induces electric volt into the probe coil and the electric volt is sampled by the magnetic RFA.

The RFA instrument is activated and the probe tip is placed maintaining a 1–3 mm distance from the smart peg, at an angle of 90°, and 3 mm above the soft tissue, otherwise the measured value may be affected. The values are expressed as numbers between 1 and 100 in ISQ. It has been reported that ISQ is affected by implant diameter, surface, form, bone contact ratio, implant site, implant system, surgical procedure, bone quality and bone height.

Histomorphologic studies report that the RFA value has a high correlation with the bone implant contact. On the contrary, other reports claim that there is no correlation between the bone density and ISQ. Therefore, RFA signifies the bone anchorage of implants but the relation of RFA and bone structure is not yet clear. Such diverse results showed, RFA value decreases during the first 2 weeks after implant placement, and this change can be related to early bone healing such as biological change and marginal alveolar bone resorption. The relationship of bone structure and RFA is not fully understood. Since primary stability is affected by bone volume or bone trabeculae structure, as well as cortical bone thickness and density, the effect of bone quality on implant stability, cannot be explained by bone **Lai C. H. et al in 2009**[13] had ISQ values over 66 at first measurement, indicating that osteotome procedure provided good primary stability, which is most important basis for implant success. **Marco T et al in 2016**[14] had a mean ISQ value 65.5 at implant placement and it increased to 74.1 at the 6 month examination. The titanium implants used in their study had been subjected to anodic oxidation, **L.Stefan et al in 2004**[15] which results in the growth of the native titanium oxide layer and the formation of a porous surface structure.

The soft tissue inflammation became nil in ostetotome group at 1 month and 3 months. Inflammation was present in 20% patients of hydraulic group at 1 month. There was no significant ($p>0.05$) difference in soft tissue inflammation between the groups at all the follow-ups. **(Gruber R , Nadir R, Haas R in 2010)** Infection was present in 20% patients in both osteotome group and Hydraulic group at 1 week. The infection became nil in osteotome group at 1 month and was present in 10% patients of hydraulic group at 1 month. There was no significant ($p>0.05$) difference in infection between the groups at all the follow-ups.

The bone implant contact ratio was insignificantly lower ($p>0.05$) among the patients of Target group (87.09±2.89) than Control group (89.08±2.64 after 6 months. There were two possible rationales of endo-sinus new bone formation. One was the osteogenic activation after sinus floor mini-fracture. The osteogenic progenitors required for osteogeneis could derive from bone marrow stroma, periosteum and microvascular walls **(Bruder et al. 1994)**[16]. When the sinus floor was fractured and pushed upwards by osteotome, the bone healing process was stimulated. The new bone might generate upwards, from the original sinus floor to the implant apex, and then reach the displaced bone core to form a new cortical line of sinus floor. Furthermore, the maxillary sinus membrane may play an even direct role in the bone healing process**. Gruber et al. (2004)**[17] conducted an in vitro study and concluded that the sinus mucosa contains mesenchymal progenitor cells and cells committed to the osteogenic lineage. Lundgren et al. (2004) also indicated that, beside the osteogenic properties, the sinus membrane could also protect the blood clot in the healing process as a barrier membrane after surgery. Gain in bone height was significantly lower ($p=0.05$) lower among the patients of Osteotome group (4.00±1.26) than hydraulic group (5.85±0.81) after 6 months. In hydraulic group the amount of bone formation after sinus lift was directly releated to volume of normal saline used for elevation. In hydraulic pressure the more surface area of schneiderian membrane was in contact with normal saline during elevation of sinus membrane as compared to osteototome because of which the area gained in hydraulic group was more. By using osteotome (Nkenke et al. 2002; Artzi et al. 2003; Sotirakis & Gonshor 2005) or combinations of ostetomes and burs (Horowitz 1997, Zitzmann & Scha¨rer 1998, Toffler 2004; Leblebicioglu et al. 2005; Li 2005; Barone et al. 2008; Fermerga ˚rd & Astrand 2008; Schmidlin et al. 2008; Nedir et al. 2009), either with (Horowitz 1997; Nkenke et al. 2002; Toffler 2004; Sotirakis & Gonshor 2005; Barone et al. 2008) or without graft biomaterials (Zitzmann & Scha¨rer 1998, Artzi et al. 2003; Leblebicioglu et al. 2005; Li 2005; Fermerga ˚rd & Astrand 2008; Schmidlin et al. 2008; Nedir et al. 2009), reported a mean vertical bone gain lower than 5 mm[25].

No statistical significant difference was found, the overall patient satisfaction was high in both study groups. In our knowledge there has been a no direct comparison between Tatum's ostetotome and hydraulic sinus lift procedure for dental implant placement, due to limited number of sinus lift procedure in a limited period of study; it is worthwhile to mention that sinus lift with hydraulic pressure has provided a viable restorative solution to edentulous areas especially in a compromised or insufficient alveolar bone volume in areas like posterior maxilla. Results are highly predictable lowered morbidity shorten the surgery duration and in turn reducing the cost of treatment. Further studies with larger number of sample size with longer follow could be done to prove its efficacy.

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