Analyze the cases of implant failures that were placed simultaneously with sinus floor elevation

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I. Introduction

Implants are commonly used in dental practice and implant-supported restoration offers a predictable treatment for tooth replacement. However there are many risk factors of implant that is generally divided into patient-related factors (general health status, smoking habits, quantity and quality of bone, oral hygiene maintenance), implant characteristics (dimensions, coating, loading), implant location, and clinician experience[1]. Factors such as the surgical technique and the type of graft material or implant can affect implant survival[2] and then the quality of implant surfaces, graft materials and surgical techniques has been developed to make high survival rates of implants.

In the maxillary posterior region, placement of longer(at least 10mm) implants may significantly improve long term results[3]. However anatomical limits are challenges to clinician such as atrophic alveolar ridge, maxillary sinus and low quality of alveolar bone[4]. To increase remaining bone height and quality of alveolar bone, elevation of the maxillary sinus floor with a lateral window was introduced by Tatum[5]. The procedure is technically demanding and invasive.

Summers[6] introduced crestal approach technique using osteotome as a less invasive procedure. Although this procedure makes less postoperative swelling, pain and short healing time but crestal approach also has disadvantage such as benign paroxysmal positional vertigo. Both of techniques have possibility of sinus membrane perforation which can make reduction of bone formation[7].

Several recent trials suggest that different implant dimensions are also associated with different failure rates[8, 9] Various graft materials, including autografts, allografts, and synthetic bone grafts, have been used to augment the volume between the sinus floor and the elevated Schneiderian membrane,[10] but there is no clear recommendation about which material is superior. However Autogenous bone grafts are still the gold standard because of its osteogenic ability.

Jang et al[11]. reported about bucco-palatal width of sinus at the apical end level of the implant in the maxillary sinus. If width of sinus is larger than 12.1 mm, study recommended autogenous bone with osteogenic potential. The reflection of the sinus medial wall by the lateral window technique is recommended if the autogenous bone cannot use.

Recently, sinus floor elevation technique has also been performed using a modified approach, such as localized management of sinus floor elevation(LMSF) by Bruschi[12]. This procedure used no graft material in

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the newly created space underneath the maxillary sinus membrane.

Besides the LMSF, the antral membrane balloon elevation, the hydraulic sinus condensing technique, and utilizing sinus drill techniques has been developed. These are simple and less invasive compared to the conventional technique.

The aim of this study is to analyze the cases of implant failures that were placed in the simultaneously with lateral approach and trans-crestal approach for maxillary sinus floor elevation.

II. Material and Methods

1. Patients

407 patients who have been treated in LivingWell dental hospital between 2003 to 2009 were selected. The patient population consisted of 246 males and 161 females ranging in age from 16 to 81 years (mean age 48.9 years). In all patients, panoramic radiographs were taken preoperatively. After 2005, cone beam computerized tomography was also taken preoperatively(i-CAT™, ISI, USA) to evaluate the anatomical figure and physiology condition of maxillary sinuses.

2. Implants

A total of 714 implants-MP-1 HA coated implant (Tapered Screw Vent™, Spline™, Zimmer, USA), FBR surfaced implant(Pitt-Easy™, Oraltronics, Germany)- were placed in grafted sinus simultaneously.(TSV:573, Spline:16, Pitt Easy:125)

3. Graft materials

The autogenous bone-mandibular ramus, mandibular symphisis, maxillary tuberosity, iliac bone-or a combination with the allograft- Puros®(Zimmer, USA), DFDB®(MTF, USA)- or alloplast-(Cerasorb®, Curasan, Germany)- was grafted under the elevated sinus floor and vertical/horizontal defect of alveolar ridges.

4. Surgical method

Patients were treated either under local anesthesia, local anesthesia with intravenous sedation. Lateral window technique, osteotome technique and sinus drill technique -Hatch Reamer®(Sinustech, Korea), DSR®(Dentimate, Korea)- technique methods were used for sinus floor elevation procedure.

The lateral approach technique was performed using a modified Caldwell Luc procedure described by Kent and Block.

After preparing the implant site with implant drills to 2 mm beneath the sinus floor, the osteotomes were inserted to expand the preparation area vertically. If the bone density too high to expand, malleting was done after more drilling or sinus drill technique was used. Less than 5mm of remaining bone height, if the bone density was low osteotome was used without drilling. When the expansion was completed without green stick fracture of sinus floor bone, LMSF was used. However, if green stick fracture was needed, bone materials were grafted after sinus floor elevation.

5. Postoperative care

Patients were followed up every 4 months for supportive care and evaluation. The mean period of reconstruction with prosthesis was 24 weeks. Instruction in brushing and interproximal cleaning was initiated as soon as the prosthetic reconstruction was connected. Panoramic radiographs were taken postoperatively, after prosthesis placement, and at yearly intervals for evaluate the peri-implant bone and maxillary sinuses. CT was also taken postoperatively, following 1.5 year postoperatively.

6. Survival criteria

Survival implants were considered those characterized by the following criteria 1) absence of mobility, 2) absence of continuous peri-implant radiolucency, 3) absence of clinical symptom. If implant had one of them, we regarded as a failure.

7. Measurement

In all of cases, remaining bone heights were meas-

ured with panoramic radiograph images and computed tomographic images. We chose 294 cases randomly(14 failure cases were included) that had computed tomographic image, bucco-palatal widths of maxillary sinus at the apical end level of implants were measured with image reformatting software (Simplant®, Materialize, Belgium). The cumulative implant survival rate(CSR) was estimated by Kaplan-Meier method.

III. Results

The cumulative implant survival rate(CSR) was 97.6% (lateral approach: 97.9%, trans-crestal approach: 97.4%). 14 implants failed during the healing period-lateral approach: 4(CSR: 98.6%), trans-crestal approach: 10(CSR: 97.4%)- and 3 implants failed after prosthetic loading- lateral approach: 2(CSR : 99.3%), trans-crestal approach: 1(CSR : 99.6%)(Fig. 1).

The average preoperative height of the maxillary alveolar bone was 7.09 mm(0.4-12.5mm) and the average width of sinus was 14.9mm(2.3mm-24mm). In failure cases the average preoperative height of the maxillary alveolar bone was 5.5mm(1mm-12.1mm) and the average width of sinus was 17.4mm(6.8mm-24mm)(Table 1).

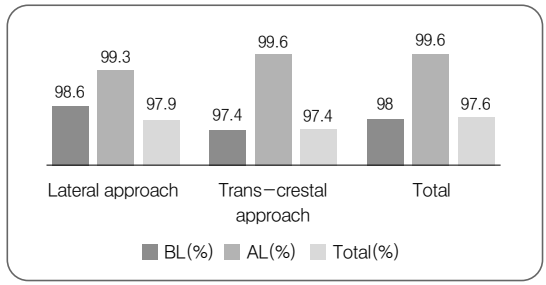

Fig. 1. Survival rates by approach procedures & loading (BL : before loading, AL: after loading).

When the width of sinus was more than 12mm, the survival rate(94.32%) was lower than 96% which was rates of under 12mm. These tendency was more prominent in trans-crestal approach, but in lateral approach, there was no significantly difference between two groups(Table 3).

Survival rates associated with diameter of implants showed no significantly difference between less than 4 mm in diameter (97.5%) versus more than 4mm in diameter(97.7%). Less than 4mm there were more failure cases than another group(Table 4).

■ Table 1. Mean of remaining bone Height

Site	Lateral approach(mm)		Crestal approach(mm)		Total(mm)	
	failure	survival	failure	survival	failure	survival
P1	none	5.07	none	9.57	none	9.41
P2	6.6	4.3	12.1	8.34	8.43	6.39
M1	5.12	3.49	3.8	7.05	4.64	5.50
M2	5.1	3.94	none	6.69	5.1	5.32
Total	4.73	3.90	5.75	7.09	9.7	7.09

(P : premolar, M: molar)

■ Table 2. Survival rates associated with remaining bone height

	LATERAL				CRESTAL				Total			
Bone height	Fail(n)	Survival rate(%)			Fail(n)	Survival rate(%)			Fail(n)	Survival rate(%)		
		BL	AL	Total		BL	AL	Total		BL	AL	Total
H≤5mm	3	203/204(100)	201/203(99)	201/204(98.5)	7	103/109(95.2)	102/103(100)	102/109(93.6)	10	306/313(97.7)	303/306(99)	303/313(97.7)
5mm<H	3	84/87(96.6)	84/84(100)	84/87(96.6)	4	311/314(99)	310/311(99.7)	310/314(98.7)	7	395/401(98.5)	394/395(99.7)	394/401(98.3)

■ Table 3. Survival rates associated with sinus width

	Crestal approach(mm)		Lateral approach(mm)		Total(mm)	
	failure(n)	survival rate(%)	failure(n)	survival rate(%)	failure(n)	survival rate(%)
D>12mm	7	101/108(93.51)	4	82/86(95.34)	11	183/194(94.32)
D≤12mm	3	75/78(96.15)	1	20/21(95.23)	4	95/99(96)

■ Table 4. Survival rates associated with diameter of implant

	Lateral approach				Crestal approach				Total			
Diameter (mm)	Fail(n)	Survival rate(%)			Fail(n)	Survival rate(%)			Fail(n)	Survival rate(%)		
		BL	AL	Total		BL	AL	Total		BL	AL	Total
D<4	3	109/110(99.1)	107/109(98.2)	107/110(97.3)	3	124/127(97.6)	124/124(100)	124/127(97.6)	6	233/237(98.3)	231/233(99.1)	231/237(97.5)
4≤D	3	178/181(98.3)	178/178(100)	178/181(98.3)	8	289/296(97.6)	288/289(99.7)	288/296(97.3)	11	467/477(97.9)	466/467(99.8)	466/477(97.7)
Total	6	287/291 (98.6)	285/287(99.3)	285/291(97.9)	11	413/423(97.6)	412/413(99.8)	412/423(97.4)	17	700/714(98.0)	697/700(99.6)	697/714(97.6)

■ Table 5. Survival rates associated with graft materials

	Lateral approach				Crestal approach				Total			
Bone material	Fail(n)	Survival rate(%)			Fail(n)	Survival rate(%)			Fail(n)	Survival rate(%)		
		BL	AL	Total		BL	AL	Total		BL	AL	Total
Autogenous,or Autogenous combination	4	261/263(99.2)	259/261(99.2)	259/263(98.5)	8	334/341(97.9)	333/334(99.7)	333/341(97.7)	12	595/604(98.5)	592/595(99.5)	592/604(98)
Allograft	1	23/24(95.8)	23/23(100)	23/24(95.8)	1	15/16(93.8)	15/15(100)	15/16(93.8)	2	38/40(95)	38/38(100)	38/40(95)
Alloplast	1	3/4(75)	3/3(100)	3/4(75)	0	4/4(100)	4/4(100)	4/4(100)	5	7/8(87.5)	7/7(100)	7/8(87.5)
None					2	60/62(96.8)	60/60(100)	62(96.8)	2	60/62(96.8)	60/60(100)	60/62(96.8)
Total	6	287/291(98.6)	285/287(99.3)	285/291(97.9)	11	413/423(97.6)	412/413(99.8)	412/423(97.4)	17	700/714(98.0)	697/700(99.6)	697/714(97.6)

Ⅳ. Discussion

Lateral approach and trans-crestal approach are main surgical methods to overcome the anatomical limits in maxiillary posterior area and two methods have been developed by many studies.

Fugazzotto[13] showed all 28 of the crestal approach sinus augmentations were successful, while 97.3% (110 of 113) of the lateral approach and 97.5% (79 of 81) of the lateral approach with simultaneous implant placement sinus augmentations were successful. Zitzman[14] reported the success rate of the osteotome technique was 95% during the 30-month study period; no failures occurred in any site treated with a lateral antrostomy. This study reported in cases of severe resorption with bone heights of 4 mm or less, the two-step lateral antrostomy had to be chosen and with residual bone heights of 4 to 6 mm, simultaneous implant placement was usually possible. In cases of moderate resorption with bone heights of more than 6mm, the osteotomy with the crestal approach was recommended. Jesen OT[15] reported implants can be placed with an osteotome technique with sinus grafting if vertical bone height is at least 5mm. Milan Jurisic[16] reported if the alveolar ridge has a vertical bone height of 5mm, primary stability of implants

may not be achieved with osteotome technique.

In present study shows a total survival rates(97.6%) of implants were placed simultaneously with sinus floor elevation. The survival rate of lateral approach was 97.9%, and the survival rate of trans-crestal approach was 97.4%. There is no significantly difference between lateral approach and trans-crestal approach. However the effect of remaining vertical bone height must be taken into considerations. Survival rates associated with remaining vertical bone height, below 5mm, trans-crestal approach and lateral approach technique showed 93.6%, 98.7% respectively.

The most commonly reported intraoperative complication of sinus augmentation is membrane perforation[17]. Membrane perforations are strongly associated with the appearance of postoperative complications and consist mostly of acute or chronic sinus infection, bacterial invasion, swelling, bleeding, wound dehiscence, loss of the graft material and a disruption of normal sinus physiologic function[7].

Bone added osteotome sinus floor elevation (BAOSFE) technique can make perforation of sinus memebrane easily, because sometimes this technique need excessive malleting force. To avoid excessive force, LMSF technique was choosed for the first in our hospital. However, when LMSF technique could not be used, bone materials were grafted after the sinus floor elevation.

Herna¢¥ndez-Alfaro[7] reported there is no significant implant survival rate at sinus membrane perforations of less than 5mm compared with perforations between 5 and 10mm. A significantly higher implant survival rate was seen in perforations between 5 and 10mm than in perforations higher than 10mm. This

■ Table 6. Characteristics of failed implants

RT	Age	Sex	site	Remaining bone height(mm)	Sinus width (mm)	Surface	Diamter (mm)	Length (mm)	Graft material	Memb	PRP	Surgical method	Time of failure	Lesion of sinus	Systmic disease or medication	smooke (cigarettes/day)
1	34	F	M2	5.7	Unknown	HA	3.7	13	None			C	BL			Unknown
2	32	M	M1	11.2	7.21	FBR	4	14	None			C	BL			Unknown
3	50	M	M1	1	24	HA	4.7	13	Auto+alloplast	M		C	BL	Sinusitis		0
4	50	M	M2	1.2	19.2	HA	4.7	13	Auto+alloplast	M		C	BL	Sinusitis		0
5	63	M	M1	2.4	17.7	HA	4.7	13	Auto+alloplast	M		C	BL	Sinusitis	HTN	Unknown
6	66	M	M1	4	Unknown	HA	3.7	13	DFDB			C	BL		G.P	Unknown
7	41	M	P2	12.1	6.8	HA	3.7	13	Auto+DFDB			C	BL			10
8	62	M	M1	10.79	13.21	FBR	4.9	14	Auto+alloplast			C	BL		HTN	0
9	45	F	M1	1.5	21.2	HA	6	13	Auto+alloplast		O	C	BL	Sinusitis		30
10	40	M	M1	3.2	11.4	HA	4.7	13	Auto+alloplast	T	O	C	AL	Sinusitis		0
11	49	M	M2	4.8	13.3	FBR	4.9	12	Auto		O	C	BL	Sinusitis	HTN	14
12	53	M	M1	2	19.2	HA	3.7	13	Auto			L	AL	Sinusitis	HTN	0
13	46	M	P2	5.6	Unknown	FBR	4.7	13	Auto			L	BL			20
14	63	M	M1	1.6	14.42	HA	3.7	13	Auto			L	AL			0
15	45	M	P2	7.61	7.6	HA	3.7	13	DFDB	M		L	BL	sinusitis		20
16	58	F	M1	7.2	15.21	HA	4.7	13	Alloplast			L	BL		HTN	0
17	42	F	M1	4.4	16.82	HA	4.7	13	Auto	M	O	L	BL			0

(T : titanium mesh, M: membrane, C: trans crestal approach, L: lateral approach, G.P: general paralysis, HTN : hypertension)

study concluded sinus membrane perforation can result in reduced bone formation and the survival rates of implants correlate inversely with the size of the perforations.

Small perforations of sinus membrane usually do not need treatment because the membrane folds on itself during the elevation[18, 19]. However, large perforations are usually managed using a bioabsorbable membrane[18-21] by placing a large lamellar bone sheet using a block graft inserted of a cancellous graft or by abandonment of the procedure. In our hospital, if the perforation was found PRP, PPP or collagen membrane were placed.

Preoperative inflammation of sinus can affect success of implant. 7 failure cases had a preoperative sinus mucosal thickening, this was half of failure cases. Tolga F.Tözüm reported Successful treatment was possible after the extraction of a periodontally involved molar with chronic sinus inflammation without any residual bone. But the study showed only one case, so clinician have to keep in mind that inflammatory sinus membrane can be perforated easier than sound sinus membrane.

Several recent study suggest that different implant dimensions are associated with different failure rates. Winkler[8] reported a significantly lower mean 3-year survival for implants less than 4 mm in diameter (90.7%) versus survival for implants more than 4 mm in diameter (94.6%). Degini[9] recently assessed the relationship between implant dimension and survival in the context of immediate functional loading of the edentulous maxilla. This study showed 99.37% survival rate for diameter above 5.25 mm versus 93.8% survival rate for diameter below 5.25 mm.

In present study, although there is no significantly difference between both of two groups(below 4mm, above 4mm), 2 of 3 implants which were removed after prosthetic loading were included in below 4mm group.

Rachel Anner[20] showed smoking and attendance in a regular supportive periodontal program were statistically associated with implant survival and patients with (treated) moderate-to-advanced chronic periodontal disease demonstrated higher implant failure rates but, this difference did not reach statistical significance. A higher degree of complications, or implant failure rates, were found in smokers with and without bone grafts[21]. In a recent study, it was found that smoking adversely affects implant survival and success and is more pronounced in areas of poor quality, trabecular bone[22]. Nitzan et al[23] reported a relationship between marginal implant bone loss and smoking habits. A higher incidence of marginal implant bone loss was found in the smoking group, which was more pronounced in the maxilla.

Peri-implantitis, defined as infection and inflammation affecting implant supporting tissues, is a leading cause of late implant failures[24]. Van Steenberghe D[25] reported although there is no direct evidence in the literature to suggest the importance of supportive therapy for implants as for periodontally treated teeth, periodontal therapy has been suggested to precede implant therapy in partially dentate patients. Hultin et al.[26] illustrates that there was an important role for regular continuous supportive periodontal therapy in implant patients to increase implant survival over time. Also, in dental implant patients, instruction in brushing and interproximal cleaning should be initiated as soon as the prosthetic reconstruction is connected.

Patients were followed up every 4 months for supportive care and evaluation in our hospital. Brushing instruction was also initiated as soon as the second operation. Maybe these efforts made low after loading failure rates(2.4%) of implants.

Many articles reported risk factors of implant that is generally divided into patient-related factors, implant characteristics, implant location, and clinician

experience. But study in relation to maxillary sinus and graft material's ability is rare.

Jang et al.[11] reported about bucco-palatal width of sinus at the apical end level of the implant in the maxillary sinus. In this report authors measured arrival distance of grafts from lateral wall to medial wall at the apical end level of the implant in the maxillary sinus with postoperative CBCT image in a total of 57 patients, 100 implants. Study showed if width of sinus is larger than 12.1mm, study recommended autogenous bone with osteogenic potential. The reflection of the sinus medial wall by the lateral window technique is recommended if the autogenous bone cannot use.

In this study, more than 12mm in width of sinus, the survival rates were low versus less than 12mm in width of sinus. These tendency was more prominent in trans-crestal approach, but in lateral approach, there was no significantly difference between two groups. Lateral approach technique can reflect medial wall of sinus membrane in order to receive the vascular supply and the osteoconductive effect.

In our hospital, clinicians placed MP-1 HA-coated or FBR surfaced implants that were over than 12mm in length of implant mainly. There were no significantly defference survival rates associated with surface types of implants and length of implants. Most of graft materials contained autogenous bone.

V. Conclusion

The results indicate that accurate measuring of remaining bone height and width of sinus, diagnosis whether sinus membrane has inflammation or not, selection of implant type and graft materials are needed to make good clinical results of simultaneous implant placement with sinus floor elevation trans-crestal approach and lateral approach for maxillary sinus elevation.

Authors also concluded that remaining bone height and width of sinus have more influence with trans-crestal approach technique while lateral approach technique didn't show and significantly difference.

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상악동 거상술과 동시 식립된 임프란트 실패 증례에 대한 분석

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이번 연구의 목적은 위축된 상악 구치부에서 측방 및 치조정을 통한 상악동저 거상술을 시행하여 동시 식립된 임프란트 중 실패한 증례들을 바탕으로 각각의 원인을 분석하고자 한다.

2003년에서 2009년 사이 리빙웰 치과병원을 내원하여 상악 구치부에 측방접근술 혹은 치조정접근술을 이용하여 상악동저를 거상하고 동시에 임프란트를 식립 시술을 받은 407명의 환자(남자는 246명, 여자는 161명, 평균연령은 49세(16-81세)이였다)에게서 식립 후 6개월이 지난 임프란트 714개를 선택하였다. 2가지 종류의 표면 처리된 임프란트- MP-1 HA coated implant(Tapered Screw Vent™, Spline™, Zimmer, USA), FBR surfaced implant(Pitt-Easy™, Oraltronics, Germany)-가 골이식된 상악동에 동시 식립되었다. 파노라마 및 CT 상(실패한 17개 중 14개)에서 잔존치조골 수직 고경 및 상악동 내외측벽간 거리를 측정하였다.

총 714개의 임프란트(측방 접근술: 291개, 치조정 접근술 : 423개) 중 17개의 임프란트가 실패 하였고 이 중 14개의 임프란트가 골유착 단계에서 실패하였고 3개의 임프란트가 보철 수복후 실패하였다. 실패한 증례들에서 잔존 치조골 수직 고경 평균 5.5mm(1.5mm-12.1mm) 이었고 이 중 5mm 이하인 경우가 17개 중 11개였다. 평균 상악동 내외측벽간 거리는 17.4mm(6.8mm-24mm)이었으며 12.1mm 이상인 경우가 14개중 10개였다.

이번 연구를 통해 골이식을 동반한 상악동저 거상술과 함께 임프란트 동시 식립시 상악동의 내외측벽간 거리 및 잔존 치조골 높이에 대한 정확한 술 전 진단이 필요하며 이를 통해 적절한 술식 및 임프란트의 종류와 이식재의 선택이 장기적인 좋은 예후를 가져오리라 사료된다. *[대한치과이식(임프란트)학회지 2010:29(1):62-70]*

Keywords :치조정 접근술, 측벽 접근술, 상악동 거상술 동시 식립, 상악동 내외측벽간 거리