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Maxillary sinus grafts for endosseous implant placement: a literature review

임프란트 식립을 위한 상악동점막 거상술 : 문헌고찰

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박 승 병

Maxillary sinus grafts for endosseous implant placement: a literature review

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박 승 병

박승병의 박사학위논문을 인준함

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본 연구의 목적은 상악 구치부 임프란트 식립 시 잔존 골량의 부족으로 상악동 거상술을 시행 받은 환자를 대상으로 연구한 문헌들을 고찰하여, 이용된 상악동 골 이식재에 따른 임프란트 식립 후 예후를 알아보는 데 있다.

1980년부터2006년까지 상악동 거상술에 대해 보고한 문헌들을 검색하였다. 본 연구에서 Medline 검색 시 사용한 주요 단어는 sinus augmentation과 bone materials이었다. 총 2452명의 환자에게 7152개의 임프란트를 식립하였으며, 이 문헌들에서는 다양한 골 이식재와 임프란트가 사용되었다. 각 문헌들에서 다양한 성공률이 나타났으며, 이 중 자가골의 성공률이 제일 높았다. 각 이식재 별로 69~100%로 다양한 성공률이 나타났으며, 그 추적기간은 0~10년까지 다양하였다. 대부분의 보고가 동일한 종류의 임프란트나 통일된 이식재를 사용하지는 않았지만, 다양한 기간의 추적검사를 통한 문헌들이 보여주듯이 대부분 높은 성공율을 보였다.

본 연구를 통해 자가골과 다른 이식재를 적절히 혼합하여 사용함으로써 상승효과를 얻을 수 있음을 알 수 있었다. 골과 임프란트의 접촉이 모든 부위에서 일률적으로 일어나는 것이 아니므로 장기적인 임프란트 기능과 연관하여 숙련된 임상 경험을 통해 꾸준한 추적 연구가 필요하리라 사료된다.

I. Introduction

An important aspect of dental implant treatment is to provide long-term, safe anchorage for the prosthesis.[1-7] The maxillary sinus is a living tissue in which resorption and deposition occur continuously; thus, its shape and location can change over time. In the maxillary molar area, resorption or involution caused by early tooth mortality can cause the maxillary sinus to expand. Maxillary sinus volume can also be increased by pneumatization of the inferior border, allowing the maxillary posterior alveolus to approach the maxillary sinus. Because this is disadvantageous for implant placement, maxillary sinus grafts have been developed to improve the osseointegration for implant placement.

In cases where resorption of the alveolar bone is minimal and the anteroposterior relationship is normal with regard to the maxillary sinus floor elevation, using the technique introduced by Tatum,[8] Boyne and James[9] reported four of experience with autogenous bone grafts. A lateral approach for maxillary sinus floor elevation was later introduced by Tatum (1986),[8] and a modified method was developed by Wood and Moore.[10] In these procedures, to compensate for insufficient alveolar bone height, diverse bone graft materials have been used separately and together, including autogenous bone, allogenic bone, xenogenic bone, and synthetic bone; however, many complications have been reported (Table I).

We reviewed several reports involving patients who underwent maxillary

sinus floor elevation to correct insufficient residual bone volume for implant placement in the maxillary molar area and assessed the prognosis after implant placement according to the material used for the maxillary sinus bone graft.

Ⅱ. Materials and Methods

A Medline search was conducted using the keywords sinus augmentation and bone materials, and 47 articles published between 1980 and 2006 that were related to maxillary sinus floor elevation surgery were reviewed.

A summary of the types of graft materials reported in the literature is shown in Table II. Additionally, the three- and five-year cumulative success rates reported at the 1996 Sinus Graft Consensus Conference[11] are shown in Table III. The success rate using autogenous bone grafts was high, as were the success rates using synthetic bone and a mixture of autogenous and allogenic bone.

Ⅲ. Results

We reviewed 47 papers describing the placement of 7,152 implants in 2,452 patients. The use of various bone graft materials and implants were reported, and the success rate varied from 69% to 100% depending on the graft material types. The highest success rate was reported for autogenous bone. The follow-up period varied from zero to ten years. In most cases, different implants and implant materials were used; however, high success rates were achieved in most studies (Tables Ⅲ, Ⅳ).

Ⅳ. Discussion

In this review, we examined the effects of the type of bone graft materials used in maxillary sinus grafts and the complications that developed during maxillary sinus floor elevation on the success of the implant.

During the maxillary sinus floor elevation procedure, several complications may arise, such as hemorrhaging in the membrane and bony window, though this can typically be managed by cauterization. The maxillary sinus may become perforated. Great care should be exercised to avoid such injuries. If the membrane becomes perforated it may be repaired by utilizing a collagen membrane.

To ensure complete healing of the graft materials, it is recommended that patients wait a minimum of fourteen months before implant placement. According to an analysis of maxillary sinus bone grafts at the 1996 Sinus Graft Consensus Conference,[11] out of 164 failures, 79 (48%) were due to complications during surgery, and among those complications, 38 (48%) were associated with perforation of the maxillary sinus membrane. Triplett and Schow[55]recommended the use of block bone, rather than particle types for cases involving a perforation larger than 5mm.[31] Jensen et al.[33] reported that perforation of the maxillary sinus membrane occurred in 35% of cases; nevertheless, among those cases involving transplanted autogenous bones, there were no reported instances of infection.

The bone height prior to surgery is an important factor influencing the

success or failure of implants. Implant removal can readily occur in cases of insufficient alveolar bone height, and, in such cases, a maxillary sinus floor bone graft should be performed. Jensen and Greer[56] reported that the success rate in cases involving less than 3mm of bone was very low, and the use of grafts in cases of 7-9 mm of bone improved the outcome. Within the maxillary sinus, two to four 15-mm implants could be placed, depending on the size of the maxillary sinus. Wheeler et al.[57] suggested following a maxillary sinus bone graft with a 13-mm long implant for best results.

Many other graft materials have been used for maxillary sinus bone grafts;[13,30,58-65]however, autogenous bone harvested from the patient is considered ideal. Autogenous bone is the best choice for areas of defective bone since it does not induce an immune response and it has osteoinductive and osteconductive functions. As a result, its potential is greater than that of allogenic bones. However, adhesion of the bones undergoing remodeling can be destroyed if a load is applied during the healing period.[62] Together with faster bone formation and remodeling, autogenous bone has higher acceptability, increased size, and bone density; however, it has one obvious shortcoming: it requires a second surgical procedure. Typical donor areas include the iliac crest, the ramus, the maxillary tuberosity, and the mandibular symphysis (Table I), though powder, fragments, segments, and other shapes have been used.[9,10,17,24,29,66,67] Most surgeons recommend autogenous bone in cases where the residual alveolar crest is less than 2mm.[67] In cases of grafts between allogenic bone and the inferior of the maxillary sinus, new bone formation is limited and typically occurs only in the vicinity of the maxillary

sinus floor. In addition, without sufficient hardness, abundant scar tissue, and distance from the maxillary sinus floor, the viability of the bone is reduced.[68]

In allogenic bone that has been decalcified and freeze-dried (DFDB), the level of bone morphogenic proteins varies depending on the preparation process, thus the osteoinductive potential is different. In fact, bone formation by osteoconduction rather than osteoinduction is likely. However, the use of a 1:1 mixture of autogenous and demineralized bone has been shown to increase the volume of the graft material and the density of the transplanted cells. A synergistic response induced greater bone formation than the use of a single graft material.[62] However, according to Holmes et al., the risk of infection with DFDB is higher, and more than twelve months may be required for the bone to mature enough to allow implant placement. Thus, DFDB is not the best choice for maxillary sinus floor elevation with implant placement.

The biocompatibility and trophism of xenogenic bones (e.g., Bio-Oss) and hydroxyapatite (HA) are significant. They provide sufficient space for new bone to grow, and additional surgery is not required. However, these materials lack osteoinductive properties, the risk of infection is higher, and their ability to withstand masticatory pressure following implant placement is unclear. Thus, these materials are used in combination in cases involving insufficient autogenous bone. It has been reported that a ratio of 3:1 (autogenous bone to HA) is adequate, and abutment connection six months after graft is recommended.

For osseointegration of implant to bone, it is desirable to have autogenous

bone in the vicinity of the implant. It is also desirable for various reasons that the bone substitution materials fill the adjacent space since they appear to play a role in maintaining the gross appearance of alveolar bone.

V. Conclusions

Maxillary sinus mucosa elevation surgery has been widely used in combination with bone grafting in cases of insufficient alveolar bone height for implant placement. However, because of the structure of the maxillary sinus, many complications can occur during the procedure. The risk of such complications can be reduced if the procedure is understood completely and appropriate measures are taken. As reviewed here, in maxillary sinus floor elevation surgery, numerous graft materials have been used; however, autogenous bone has been shown to be associated with a high rate of bone formation. In addition, a synergistic effect has been observed for autogenous bone mixed with other graft materials. Contact between bone and implant does not occur evenly in all areas. Thus, it is important that long-term clinical follow-up is continued after implant placement.

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Table I. Intraoperative, early-postoperative, and late-postoperative complicationsand sequelae following sinus bone grafts

Complications	Sequelae
Intraoperative	
Bleeding	Obstruction of ostium
Tear in buccal flap	Inadequate bone grafting
Perforation of sinus membrane	Damage to adjacent teeth
Early post-operative	
Wound dehiscence	Acute infection
Bleeding	Loss of graft material
Exposure of membrane	Failure of implant
Parenthesia of infra-orbital nerve	Oro-antral fistula
Late post-operative	
Loss of graft material	Invasion of soft tissue to bony window
Failure of implant	Cyst in maxillary sinus
Oro-antral fistula	Chronic maxillary sinusitis
Migration of implant	Chronic infection

Table II. Graft Types

A. Block
Non-vascularized
Iliac
Calvarium
Rib
Mandible: symphysis
Maxilla: tuberosity
Source unknown
B. Particulate
1. Autogenous
Iliac
Tibia
Mandible: ramus and coronoid process
2. Alloplastic plus allogenic: HA + DFDB
3. Autogenous plus allogenic: iliac + DFDB
4. Autogenous plus alloplastic: iliac + HA, Source unknown + HA

HA, hydroxyapatite DFDBA, demineralized freeze-dried bone allograft.

Table Ⅲ. Success rates accoding to graft materials

Graft materials	No. of implants	3 years	5 years
AP	163	98%	98%
AP+X	125	98%	98%
AP+AL	563	93%	90%
AL	254	85%	85%
AL+X	199	80%	
AU (particulate)	264	93%	90%
AU+AP	331	91%	90%
AU+AL	124	82%	
AU+AL+X	306	96%	
AU+AL+AP	205	93%	93%

AP, alloplastic materials X, xenogenic materials AL, allogenic bone AU, autogenous bone graft.

Table Ⅳ. Longitudinal reports on sinus elevation

Author	Patient No.	Site No.	Implant No.	Graft material	Type of implant and length	Perforation	Length of study	Success rate (%)
Boyne & James[9] (1980)	11			Au (hip)				
Tatum[8] (1986)				Au				
Misch[12] (1987)		170		TCP+DMB +blood			6 M	
Smiler & Holmes[13] (1987)	4	5	12	porous HA particles	endosteal root form		26-97 M	
Wood & Moore[10] (1988)	2	2	5	Au (ramus, coronoid)				100%
Kent & Block[14] (1989)	11	18	44	Au (hip)	HA-coated endosseous implant (Cakitek)	small (no Tx.) large (graft)	16-30 M	100%
Whittaker et al.[15] (1989)	1	1	4	osteogen+DMB +cortical bone				100%
Jensen et al.[16] (1990)	11	18	44	Au (hip)			46 M	75%
Hall & McKenna[17] (1991)	15	30		Au (hip)				90%
Hirsch & Ericsson[18] (1991)				Au (chin)				
Wagner[19] (1991)		63		osteogen+blood				

Jensen & Sindet-Pedersen[20] (1991)	26	31	107	Au (chin)			6-32 M	93.5%
Smiler et al.[21] (1992)	36	66	198	porous HA			10-12 M	95%
Smiler et al.[21] (1992)		21	56	Bio-oss+DMB (3:1)			10-12 M	95%
Smiler et al.[21] (1992)		106		osteogen+blood +collagen			10-12 M	95%
Smiler et al.[21] (1992)	72	81		osteogen+DMB			10-12 M	95%
Tidwell et al.[22] (1992)	48	48	267	Au+HA	HA-coated IMZ endosseous implant	Explanation of treatment necessity based on a 5 mm standard	23-39 M	93.3%
Loukota et al.[23] (1992)	7		27	Au (hip)		Perforation in 1 case (no symptoms)	22-24 M	
Jensen et al.[24] (1992)	15	26	74	Auto-radiated mineralized cancellous bone, DFDB				69%

Block & Kent[25] (1993)	32	51	173	AU (hip)		Failure due to a large tear at 1graft site	36 M	100%
Block & Kent[25] (1993)	32	51	173	18 cases of iliac bone, ZB+DFDBA (1:1) 33				75%
Tolman[26] (1993)		20		Au (hip)				93%
Small et al.[27] (1993)	27	45	111	DMB+porous HA		No perforation		100%
Lozada et al.[28] (1993)	120	69	298	Au+Al+Ap				85%
Raghoebar et al.[29] (1993)	25	47	93			Perforation at 8 sites (5 Failures)	16M	94.2%
Raghoebar et al.29 (1993)	25	47	86	Au (hip)				100%
Raghoebar et al.29 (1993)	25	47	6	Au (symphysis)				
Raghoebar et al.29 (1993)	25	47	1	Au (tuber)				100%
Moy et al.[30] (1993)	5		19	Porous HA, DFDB, Symphysis				89.4%
Keller et al.[31] (1994)	20	23	66	Au (hip)	Branemark		15 Y	92%

Chiapasco & Ronchi[32] (1994)	30	43	124	Au+HA				93.5%
Jensen et al.[33] (1994)	98	128 (sinus) 34 (nasal)	291	Autobone		Perforation at 45 sites (19 Failures)	12-58 M	93.5%
Misch & Pietsh[34] (1994)	20	20	148	iliac bone(block)	Branemark, Nobelpharma swedevent, Dentsply			97.9%
Zinner & Small[35] (1996)	50	57	215	DMB+ porous HA			5 Y	98.6%
Olson et al.[36] (1997)	27	42	102	Autobone (14/22/57) DFDB (4/4/8), HA+DFDB (1:1) (9/12/29), auto+DFDB (3/4/8)	30 HA-coated cylinders, 43 HA-coated cylinders 10-16 implants, 1335 implants (34%) 167 implants (8%)		3-12 M	99.0%
Peleg et al.[37] (1998)	20	20	55	Au (symphysis) +DFDBA			26.4 M (15-39)	100%

van den Bergh et al.[38] (1998)	42	62	161	Auto (iliac)	ITI screw type (2nd stage)	Perforation at 3 sites (no failures)	1-6 Y	100%
Peleg et al.[39] (1999)	63	63	160	Au (symphysis) +DFDBA	HA-coated integral cylindrical imp. (Sulzer Calcitek)		2-4 Y	100%
Khoury[40] (1999)	216	216	467	Au (symphysis, retromolar)	IMZ (Frident), Branemark (Nobel Biocare), Frialit-2 (Frident)	Perforation at 51 sites (14 failures, 28 implants)	2 Y	94%
van den Bergh et al.[41] (2000)	24	30	69	DFDB	ITI full body screw implant: rough surface	6 perforations (DFDBA)	10 M	100%
Yildirim et al.[42] (2001)	12	13	36	Bio-oss +autogenous bone	Branemark system implant			
Pinholt[43] (2003)	25		158	iliac+mandible	Branemark system implant (78): machined surface ITI (80) : SLA surface		20-67 M	B: 81% I: 98%

Stricker et al.[44] (2003)	41		183	Autogenous bone	SLA surface (ITI)	Perforation under 2mm → fibrin glue	20-67 M 15-40 M	100%
Hatano et al.[45] (2004)	191		361	Auto: (Bio-oss) = 2:1			10 Y	94.2%
Andreana et al.[46] (2004)	6	6	14	Cerasorb+ DFDBA (capset)	3.7*13: Paragon24. 7*10: Paragon23. 75*10: Biolock23. 75*10: Biolock 3.75*10: Nobel		12-30 M	100%
Deporter et al.[47] (2005)	70		104	bovine hydroxyapatite	Endpore implant (Innova)			98%
Zijderveld et al.[48] (2005)	10	16	41	beta-calcium phosphate (Cerasorb) Autogenous chin bone	ITI full body: screw type			100%
Butz & Huys[49] (2005)	20	22	56	Synthetic graft (Bioplant HTR)			7 Y	
Hallman et al.[50] (2005)			108	Auto+deproteinized bovine bone →(20:80)			3 Y	86%

Peleg et al.[51] (2006)	731	2132	Auto xeno allobone	Screw type (1374) HA-coated cylinder (758)	9 Y	97.9%
Lindenmuller & Lambrecht[52] (2006)	80	201	Autogenous bone ceros 82 Algi pore	ITI (98%), Frialit (80%)		92%
Qin et al.[53] (2006)	122	157	Auto xeno allobone	Length: 8-11mm		100%
Maiorana et al.[54] (2006)	34	37	Alloplastic xenogenic	Flialit-2		97.3%

Au, autogenous bone graft Al, allogenic bone Ap, alloplastic materials osteogen, HA resorb DMB, demineralized bone xeno, xenogenic bone DFDBA, demineralized freeze-dried bone allograft tuber, maxillary tuberosity HA, hydroxyapatite Y, years M, months Perfo, Perforation.

저작물 이용 허락서

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논문제목	한글: 임프란트 식립을 위한 상악동점막 거상술: 문헌고찰 영문: Maxillary sinus grafts for endosseous implant placement: a literature review				

본인이 저작한 위의 저작물에 대하여 다음과 같은 조건아래 -조선대학교가 저작물을 이용할 수 있도록 허락하고 동의합니다.

- 다 음 -

1. 저작물의 DB구축 및 인터넷을 포함한 정보통신망에의 공개를 위한 저작물의 복제, 기억장치에의 저장, 전송 등을 허락함.
2. 위의 목적을 위하여 필요한 범위 내에서의 편집·형식상의 변경을 허락함. 다만, 저작물의 내용변경은 금지함.
3. 배포·전송된 저작물의 영리적 목적을 위한 복제, 저장, 전송 등은 금지함.
4. 저작물에 대한 이용기간은 5년으로 하고, 기간종료 3개월 이내에 별도의 의사표시가 없을 경우에는 저작물의 이용기간을 계속 연장함.
5. 해당 저작물의 저작권을 타인에게 양도하거나 또는 출판을 허락을 하였을 경우에는 1개월 이내에 대학에 이를 통보함.
6. 조선대학교는 저작물의 이용허락 이후 해당 저작물로 인하여 발생하는 타인에 의한 권리 침해에 대하여 일체의 법적 책임을 지지 않음.
7. 소속대학의 협정기관에 저작물의 제공 및 인터넷 등 정보통신망을 이용한 저작물의 전송·출력을 허락함.

2009년 2월 일

저작자 : 박 승병 (서명 또는 인)

조선대학교 총장 귀하