LITERATURE

IDEAL BONE GRAFT MATERIAL

PROPERTIES REQUIRED	
OSTEOCONDUCTION	provides scaffolds for bone regeneration
OSTEOINDUCTION	promotes the recruitment of boneforming cells, such as undifferentiated cells and preosteoblasts, and formation of bone from these cells
OSTEOPROLIFERATION	the induction of cells contained in the graft material to promote bone regeneration

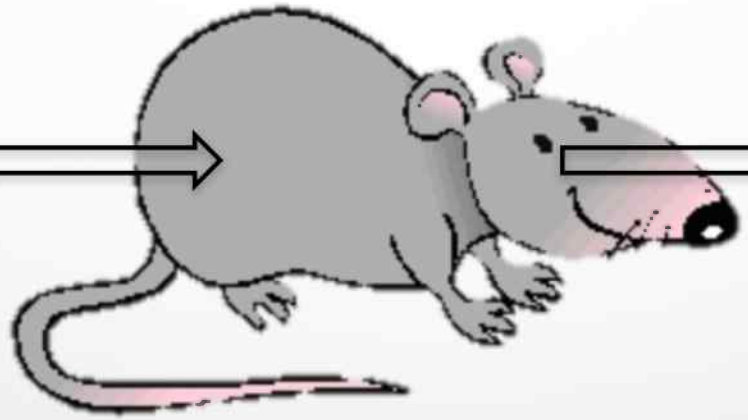
A New Method for Alveolar Bone Repair Using Extracted Teeth for the Graft Material
T.Nampo, J Watahiki, A Enomoto
J Periodontol 2010;81:1264-1272.

TYPE	ADVANTAGES	DISADVANTAGES	QUALITY
AUTOGENOUS BONE	promotes osteogenesis, osteoinduction, osteoconduction, osteoproliferation,and rapid healing	harvest volume is limited, resorption is unavoidable, and a second defect is induced in the donor area (better from neural crest)	3
AUTOGRAFT HUMAN BONE demineralized freeze-dried bone allografts	promotes osteogenesis, osteoinduction, osteoconduction, and rapid healing lack	induce immune rejection	2
XENOGRAFT bovine bone and coral	Optimal scaffol, osteoconduction	only show osteoconduction, Rapid resorption or no resorption , religion risks, risk of BSE infection *	1
ALLOPLAST synthetic ceramics for biologic use, b-tricalcium phosphate [b-TCP] and hydroxyapatite	Optimal scaffol, osteoconduction	Rapid or no resorption, lack osteoproliferation	1

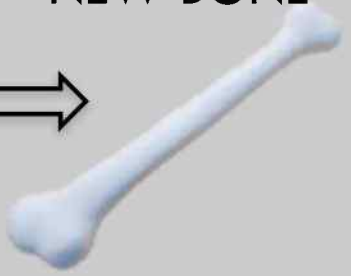
Development of a novel bone grafting material using autogenous teeth
Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2010;109:496-503
YK Kim SG Kim JH Byeon

BONE INDUCTION

DEMINERALIZED DENTIN

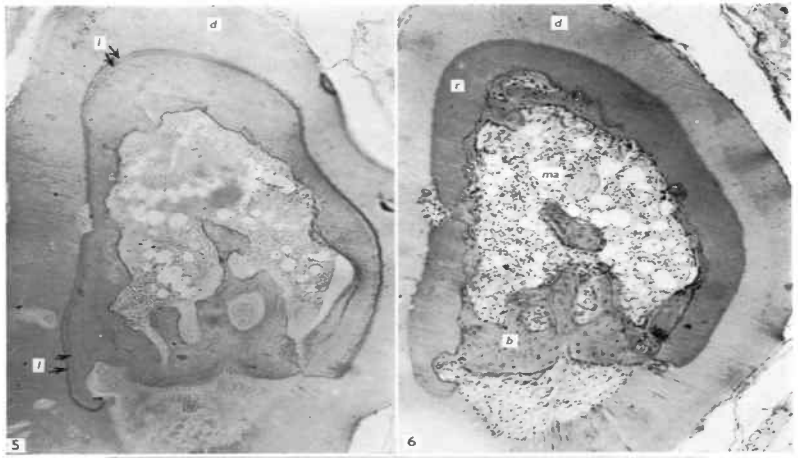


NEW BONE



Bone induction by decalcified dentin implanted into oral, osseous and muscle tissues
Arch Oral Biol, 12: 999-1008,1967.
Yeomans JD, and Urist MR

68 rats
Demineralized tooth
Implantated on muscle



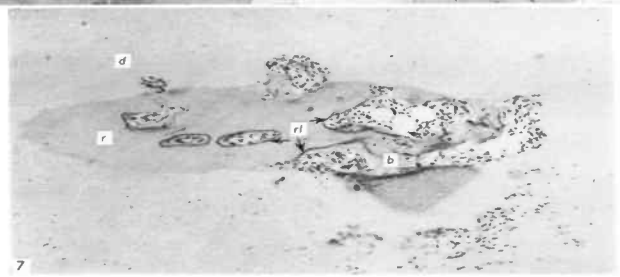


Fig. 5. Intramuscular implant of decalcified 'isogeneic' dentine at 28 days. Lead acetate given 7 and 3 days before death. *l*, 'lead lines'; *d*, decalcified dentine matrix. Toned with gold chloride and counterstained with eosin × 108.

Fig. 6. Serial section similar to that shown in Fig. 5. *r*, recalcified matrix; *d*, decalcified matrix; *b*, new bone; *ma*, mixed haemopoietic fatty marrow. H. & E. × 108.

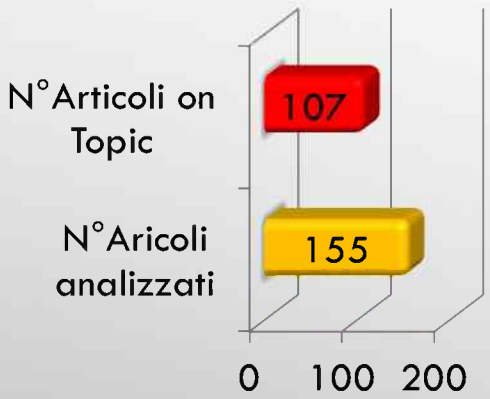
Fig. 7. Intramuscular implant of decalcified 'isogeneic' dentine at 40 days. *r*, recalcified matrix; *d*, decalcified matrix; *b*, new bone; *rl*, cement reversal lines. H. & E. × 43.

FIRST IMAGES OF DENTINE CREATE BONE IN MUSCLE

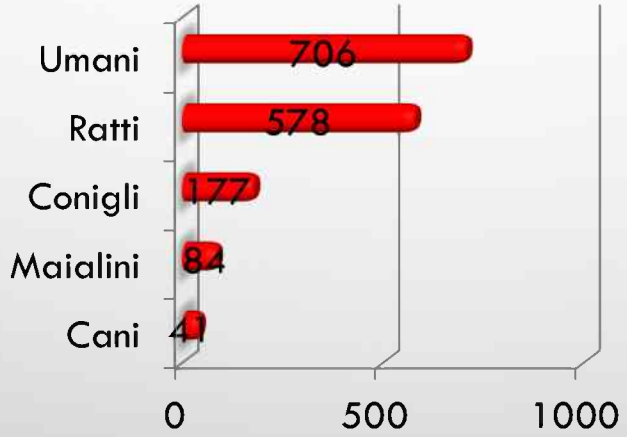
BONE INDUCTION IN IMPLANTS OF DECALCIFIED BONE AND DENTINE
J.ANAT. 1975,119;2:359-367
G.J.LINDEN

LITERATURE REVIEW SINCE 2015

LITERATURE REVIEW FROM 1965

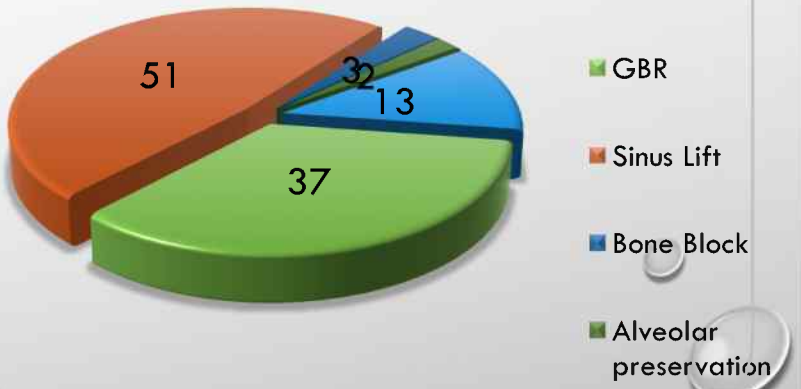


CLINICAL CASES ON TOPIC



CLINICAL CASES DEMINERALIZED DENTIN IN HUMANS

481 Casi clinici su umani 2009-2015



FOCUS POINTS FROM LITERATURE

- **DEMINERALIZATION**
- **COLLAGEN TYPE I**
- **NEURAL CREST DERIVATION**
- **PRESENCE OF GROWTH FACTORS**
- **X-RAY DIFFRACTION**
- **CONSERVATION**

DEMINERALIZATION

The demineralization process is required for freeing the various GROWTH FACTORS AND PROTEINS, since the release of the growth factors is sometimes blocked by the presence of hydroxyapatite crystals

Tooth derived bone graft material
YK Kim, J Lee
j.Korean ass oral max surg 2013:39:103-111

BONE was induced when DEMINERALIZED DENTIN was grafted in the lapine,porcine and MOUSE muscles.
the DECALCIFICATION OF DENTIN is believed to induce the **RELEASE OF BMP** thereby leading to osteoinduction

Tooth derived bone graft material
YK Kim, J Lee
j.Korean association oral maxillo surgery 2013:39:103-111

Through the reduction of the mineral phase,
DEMINERALIZATION SUPPORT THE RELEASE OF SUCH GFS FROM THE TOOTH MATRIX

Blum, B., et al.,
Measurement of bone morphogenetic proteins and other growth factors in demineralized bone matrix. Orthopedics, 2004. **27**(1 Suppl): p. s161-5.

NEURAL CREST DERIVATION COLLAGEN TYPE 1

NEURAL CREST DERIVATION

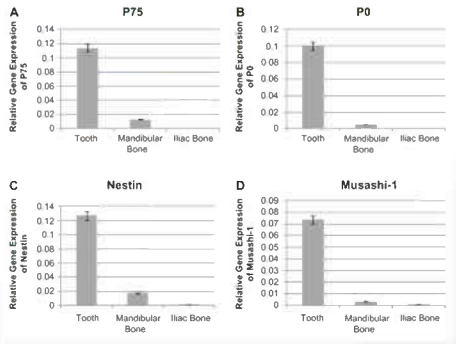
Both TOOTH and ALVEOLAR BONE are derived from neural crest cells and are made up of the **SAME TYPE I COLLAGEN**
Tissues derived from the neural crest include the maxillofacial bones (excluding the occipital, sphenoid, temporal, and ethmoid bones); cartilage; teeth; and nerve and glial cells

A New Method for Alveolar Bone Repair Using Extracted Teeth for the Graft Material
T.Nampo, J Watahiki, A Enomoto
J Periodontol 2010;81:1264-1272.

Dentin and bone are mineralized tissues and almost similar in chemical components. Both DDM and DBM are composed of predominantly type I collagen (95%) and THE REMAINING AS NON-COLLAGENOUS PROTEINS INCLUDING SMALL AMOUNT OF GROWTH FACTORS
In other words, DDM and DBM can be defined as acid-insoluble collagen binding bone morphogenetic proteins (BMPs), which are member of transforming growth factor-beta (TGF-β) super-family

Human dentin as novel biomaterial for bone regeneration
masaru murata1, toshiyuki akazawa2, masaharu mitsugi3
www.Intechopen.Com biomaterials – physics and chemistry

GROUP 1	TOOTH GROUP
GROUP 2	ILIAC BONE
GROUP 3	MANDIBULAR BONE



showing that the EXTRACTED TEETH contained numerous **undifferentiated** neural crest–derived cells compared to the other tissues.

A New Method for Alveolar Bone Repair Using Extracted Teeth for the Graft Material
Tomoki Nampo,* Junichi Watahiki,* Akiko Enomoto,
J Periodontol 2010;81:1264-1272

DENTIN CONTAINS BMPS, WHICH INDUCE BONE FORMATION AND NONCOLLAGENOUS PROTEINS SUCH AS OSTEOCALCIN, OSTEONECTIN, AND DENTIN PHOSPHOPROTEIN

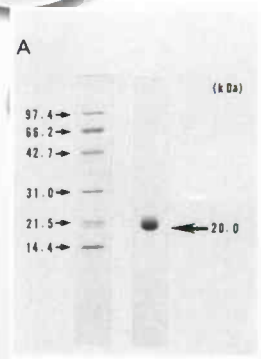
Urist, M. R, & Strates, B. S. Bone morphogenetic protein.
J Dent Res (1971). , 50,
1393-406.

HIGHLY SOLUBLE, bmp's DO NOT EXERT OSTEOINDUCTIVE EFFECTS WHEN USED ALONE. **Carriers are used to force bmps to stay at the implant site.** When used without any carrier dispersed immediately. Bmp requires an appropriate carrier for clinical use
The bmp purified was highly soluble in vivo .
Human ddm of vital teeth origin induced bone and cartilage.
Bmp-2 strongly accelerated bone formation in the ddm carrier system

Tooth-derived bone graft material
j korean assoc oral maxillofac surg 2013;39:103-111)
young-kyun kim, junho lee, in-woong um, kyung-wook kim, masaru murata, toshiyuki akazawa, masaharu mitsugi

GROWTH FACTORS

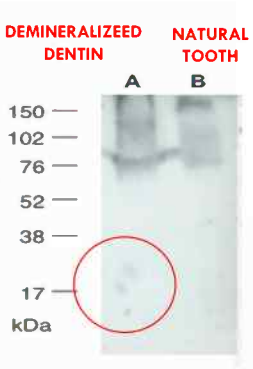
GROWTH FACTORS



BMP was extracted from Human dentin matrix and induced the formation of new bone within 3 weeks on implantation in Rats.

SDS-PAGE revealed a clear band at the site corresponding to 20.0 kDa

HUMAN DENTIN-MATRIX-DERIVED BONE MORPHOGENETIC PROTEIN.
BESSHO K1, TANAKA N, MATSUMOTO J, TAGAWA T, MURATA M.
J DENT RES. 1991 MAR;70(3):171-5.



Healing Mechanism and Clinical Application of Autogenous Tooth Bone Graft Material
Y-K Kim, JK Lee, K Kim, In-W Um and M Murata
http://dx.doi.org/10.5772/53200

DENTIN	CEMENTUM
Insulin-like growth factor IGF-II	TGF-b
Bone morphogenetic protein BMP-2	IGF-I
Transforming growth factor TGF-b 19	Type I and II collagen

DENTIN PROTEINS COMMON WITH BONE
Osteopontin OPN
Bone sialoprotein BSP
osteocalcin
Dentin sialopretein DSP
Dentin matrix protein-1 DMP-1
Type 1 collagen
osterix
Cbfa1 RUNx2

A New Method for Alveolar Bone Repair Using Extracted Teeth for the Graft Material
Tomoki Nampo,* Junichi Watahiki,* Akiko Enomoto,
J Periodontol 2010;81:1264-1272.

GROWTH FACTORS	Concentration
TGF-B	0.017
IGF-I	0.06
IGF-II	0.52

ALL 3 GROWTH FACTORS WERE PRESENT

Human dentin as novel biomaterial for bone regeneration
masaru murata1, toshiyuki akazawa2, masaharu mitsugi3
www.Intechopen.Com biomaterials – physics and chemistry

WHY THE BMP'S ARE IN THE TOOTH ?

Bioactive growth factors (GFs), such transforming growth factor-β (TGF-β)
and bone morphogenic proteins (BMPs),
which are known to be present in and released from dentin, **ARE INVOLVED IN DENTAL TISSUE REPAIR**

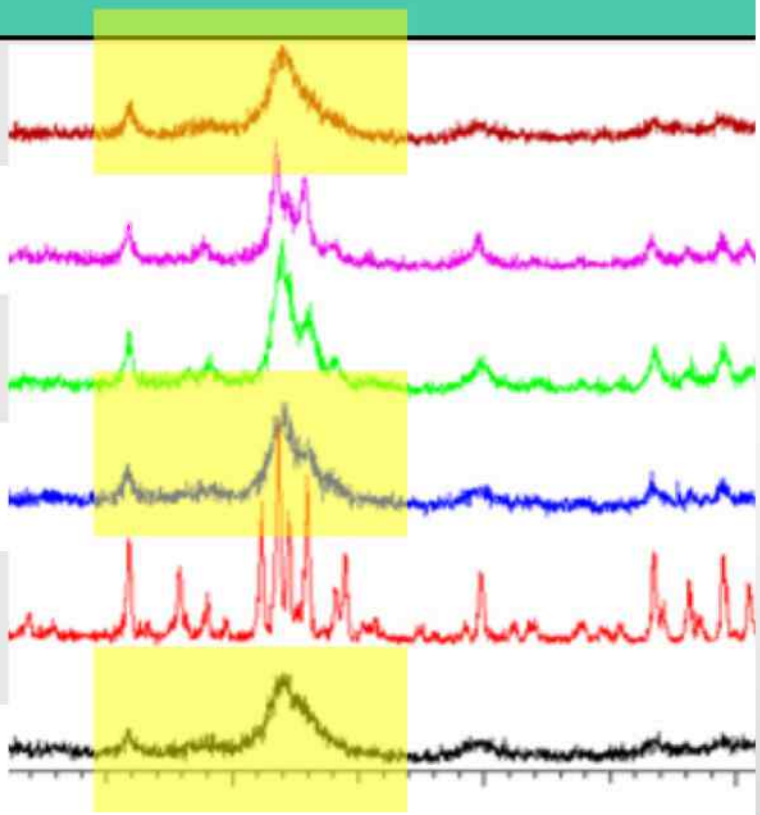
NAKASHIMA, M., *BONE MORPHOGENETIC PROTEINS IN DENTIN REGENERATION FOR POTENTIAL USE IN ENDODONTIC THERAPY*. CYTOKINE GROWTH FACTOR REV, 2005. **16**(3): P. 369-76.
IOHARA, K., ET AL., *DENTIN REGENERATION BY DENTAL PULP STEM CELL THERAPY WITH RECOMBINANT HUMAN BONE MORPHOGENETIC PROTEIN 2*. J DENT RES, 2004. **83**(8): P. 590-5.

BMPs have a role during embryonic tooth development in stimulating osteodifferentiation and in **INDUCING BONE FORMATION**

YANG, W., ET AL., *BMP2 IS REQUIRED FOR ODONTOBLAST DIFFERENTIATION AND PULP VASCULOGENESIS*. J DENT RES, 2012. **91**(1): P. 58-64.
YAGIHASHI, K., ET AL., *DEMINERALIZED DENTIN MATRIX ACTS AS A SCAFFOLD FOR REPAIR OF ARTICULAR CARTILAGE DEFECTS*. CALCIF TISSUE INT, 2009. **84**(3): P. 210-20.

X-RAY DIFFRACTION (XRD)

TYPE OF SUBSTITUTE	SOLUBILITY
TOOTH DENTIN	
TOOTH ENAMEL	
XENOGRAFT (BIOOSS)	
ALLOGRAFT (OTHER HUMAN)	
ALLOPLASTIC (MBCP)	
AUTOGENOUS BONE	



Priya, et al reported that the extensive dissolution of calcium phosphate composites, which release calcium and phosphorus ions, induces the re-precipitation of the apatite onto the surfaces

Autogenous teeth used for bone grafting: A comparison to traditional grafting materials
Oral Surg Oral Med Oral Pathol Oral Radiol. (2013)
Kim, Y. K, Kim, S. G, Yun, P. Y, et al

	DENTIN	BONE
	Percentage by weight	
Ca	26-28	24.0
P (PO4 or HPO4)	12.2-13.2	11.2
P (pyrophosphate)	0.05	0.05
CO2	3.0-3.5	3.9
Na	0.7	0.5
Mg	0.8-1.0	0.3
Cl	0.4	0.01
K	0.02-0.04	0.2
	Parts per million (ppm)	
Zn	200-700 ppm	
F	50-10.000 ppm	5.000 ppm
Fe	60-150 ppm	
Sr	100-600 ppm	

Inorganic constituents of dentine and bone
Min et al. : Oral biochemistry, 2007

CONSERVATION

MIDDLE AGE TOOTH

THE MIDDLE AGE DENTIN CONTAINS GROWTH FACTORS: INSULIN-LIKE GROWTH FACTOR (IGF)-II, BONE MORPHOGENETIC PROTEIN (BMP)-2, AND TRANSFORMING GROWTH FACTOR (TGF)-B.

Schmidt-Schultz TH, Schultz M.
Intact growth factors are conserved in the extracellular matrix of ancient human bone and teeth: A storehouse for the study of human evolution in health and disease.
Biol Chem 2005;386:767-776.

LITERATURE IN VIVO?

PARTICIPANTS 43	BIO-OSS	DEMINERALIZED DENTIN
28 IMPLANTS	ISQ 70.59	
29 IMPLANTS		ISQ 64.92
DENSITY RESIDUAL BONE PRE OPERATIVE	421.73	380.28
DENSITY POST OPERTIVE	968.15	981.80
DENSITY RELATED	1486.27	1232.02
PROPORTION NEW BONE TOTAL BONE	55.58%	60%34
HISTOMORPHOMETRIC ANALYSIS NEW BONE	26.49%	31.07%
HISTOMORPHOMETRIC ANALYSIS RESIDUAL GRAFT	31.12%	29.00%

4 MONTHS AFTER GRAFT

A PROSPECTIVE STUDY ON THE EFFECTIVENESS OF NEWLY DEVELOPED AUTOGENOUS TOOTH BONE GRAFT MATERIAL FOR SINUS BONE GRAFT PROCEDURE

SH JUN, JS AHN, JI LEE

J ADV PROSTHODONT 2014;6:528-38

CONCLUSIONS

OUR RESULTS SHOWED THAT AUTOGENOUS TOOTH BONE GRAFT MATERIALS HAVE STRUCTURES AND PHYSICOCHEMICAL CHARACTERISTICS THAT ARE MOST SIMILAR TO THOSE OF AUTOGENOUS CORTICAL BONES. AUTOGENOUS TOOTH BONE GRAFT MATERIALS ARE BIODEGRADABLE BIOMATERIALS WITH COMPACT MICROPOROUS AND LOW CRYSTALLINE STRUCTURES.

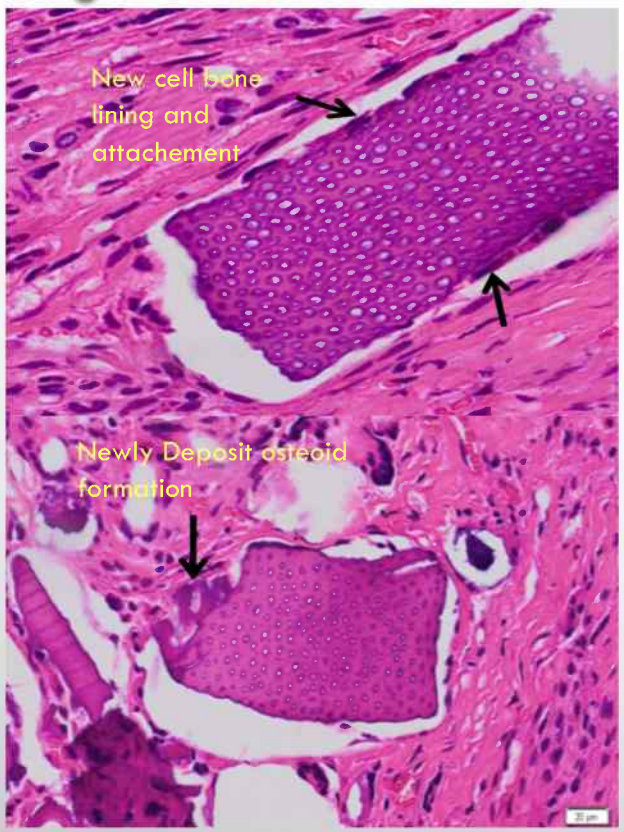
A prospective study on the effectiveness of newly developed autogenous tooth bone graft material for sinus bone graft procedure

SH Jun, JS Ahn, JI Lee

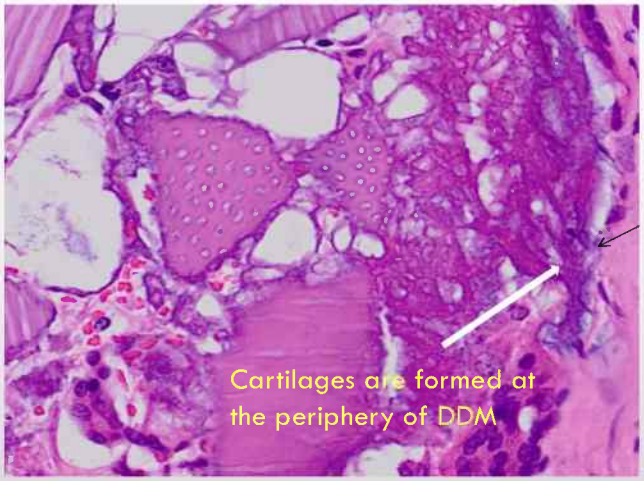
J Adv Prosthodont 2014;6:528-38

IN VIVO TEST
DDM IN MUSCOLAR TISSUE OF 15 MICE

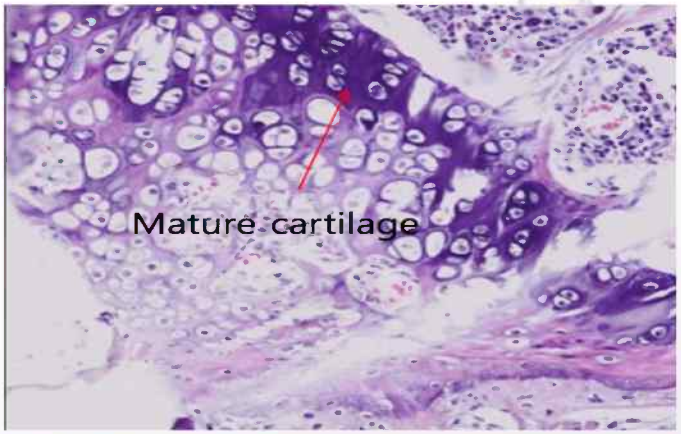
2 weeks



5 weeks



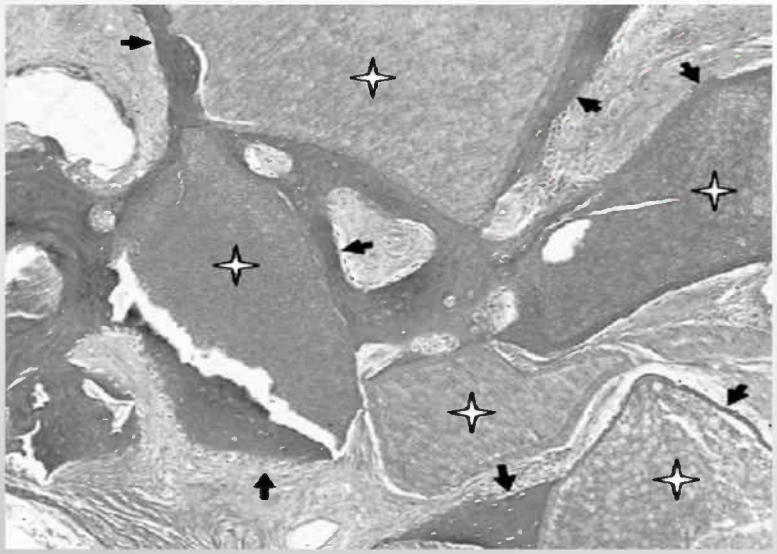
8 weeks



healing mechanism and clinical application of autogenous tooth bone graft material advanced in biomaterials science and biomaterial application http://dx.doi.org/10.5772/53200 Young-Kyun Kim, Jeong Keun Lee, Kyung-Wook Kim, In-Woong Um and Masaru Murata

MINI PIGS CRANIUM
DDM TEST
DEFECT LIKE CONTROl

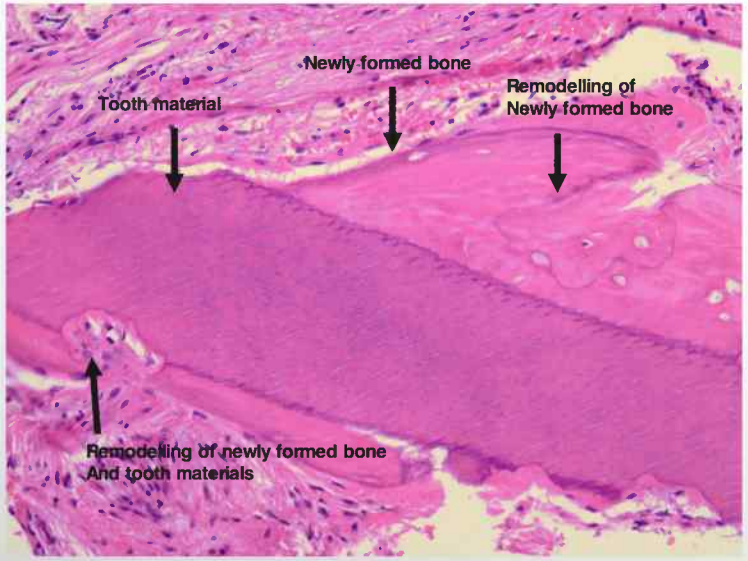
8 weeks
New bone is formed around
the DDM granules
DDM
New bone



12 weeks
Extensive bone formation around DDM

healing mechanism and clinical application of autogenous tooth bone graft material advanced in biomaterials science and biomaterial application http://dx.doi.org/10.5772/53200 Young-Kyun Kim, Jeong Keun Lee, Kyung-Wook Kim, In-Woong Um and Masaru Murata

6 PATIENTS
GBR + IMPLANTS



AFTER 3 MONTHS

AGE/SEX	SITE	HEALING PERIOD	NEW-BONE FORMATION %
40/M	24	3	74%
28/F	17	4	87%
47/F	17	6	46%
50/M	24	5	73%
43/F	36	3	52%
61/M	25-27	6	68%

healing mechanism and clinical application of autogenous tooth bone graft material advanced in biomaterials science and biomaterial application http://dx.doi.org/10.5772/53200 Young-Kyun Kim, Jeong Keun Lee, Kyung-Wook Kim, In-Woong Um and Masaru Murata

조선대학교 CHOSUN UNIVERSITY

SNUH SEOUL NATIONAL UNIVERSITY BUNDANG HOSPITAL

N° OF IMPLANTS	N° OF PATIENTS	FROM	TO	SURVIVAL RATE
100	51	JULY 2009	NOVEMBER 2010	96,15%

Jeong, K. I, Kim, S. G, Kim, Y. K, Oh, J. S, Jeong, M. A, & Park, J. J. Clinical Study of Graft Materials Using Autogenous Teeth in Maxillary Sinus ugmentation. Implant Dent (2011). , 20(6), 471-475.

SNUH SEOUL NATIONAL UNIVERSITY BUNDANG HOSPITAL

AVERAGE AGE	PATIENTS	FROM	TO	N°OF IMPLANTS
52.1+/- 11.86%	24 SINUS LIFT	OCTOBER 2007	SEPTEMBER 2009	37

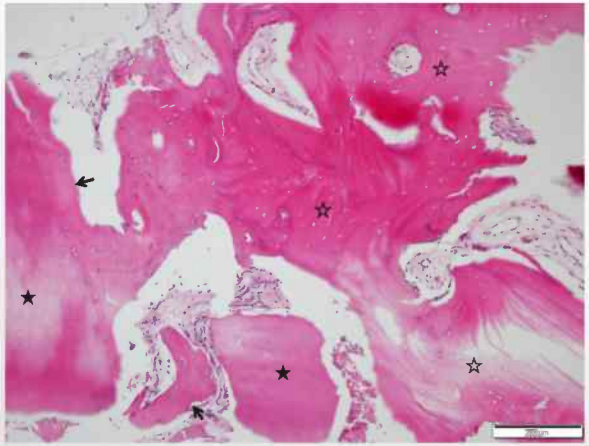
AFTER 4 MONTHS	DEMINERALIZED DENTIN	BIOCERA	BIOOSS
NEW BONE FORMATION	52.5+/- 10.7%	52.0+/-23.4%	51.0+/-18.3%
RATIO OF WOVEN BONE TO LAMELLA BONE	82.8+/-15.3%	36.7+/-59.3	31.0+/-51.2%

Lee, J. Y, Kim, Y. K, Kim, S. G, & Lim, S. C. Histomorphometric study of sinus bone graft using various graft material. J Dental Rehabilitation and Applied Science (2011). , 27, 141-147.

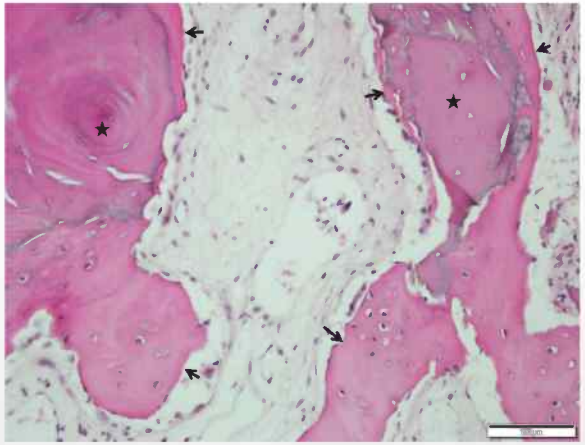
NEW BONE
IMPLANT CHIP

IN SINUS ELEVATION = BIOOSS

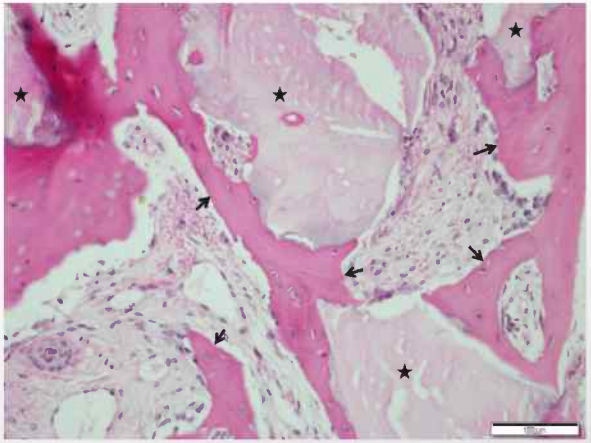
DDM



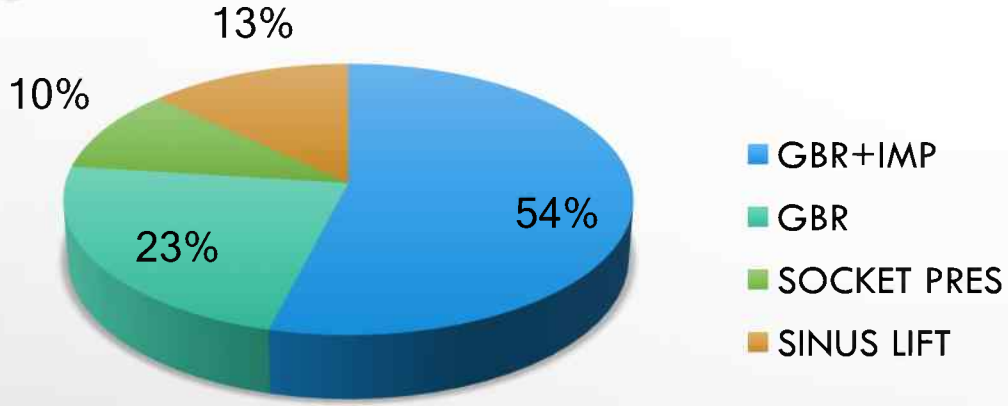
BIOCERA



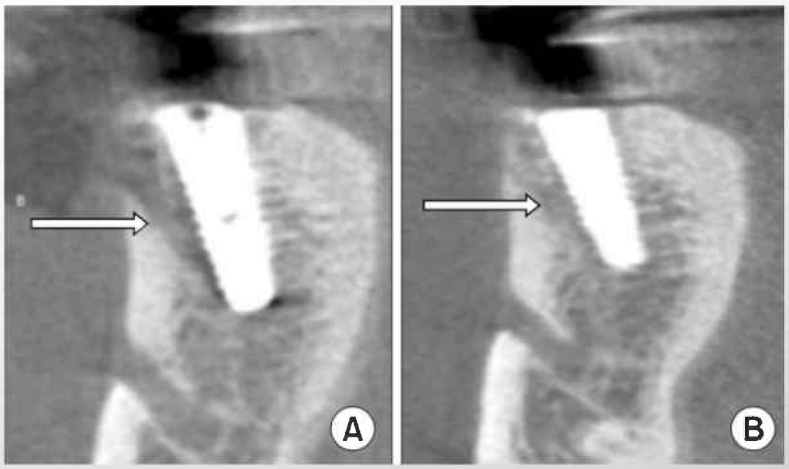
BIOOSS



Lee, J. Y, Kim, Y. K, Kim, S. G, & Lim, S. C. Histomorphometric study of sinus bone graft using various graft material. J Dental Rehabilitation and Applied Science (2011). , 27, 141-147.

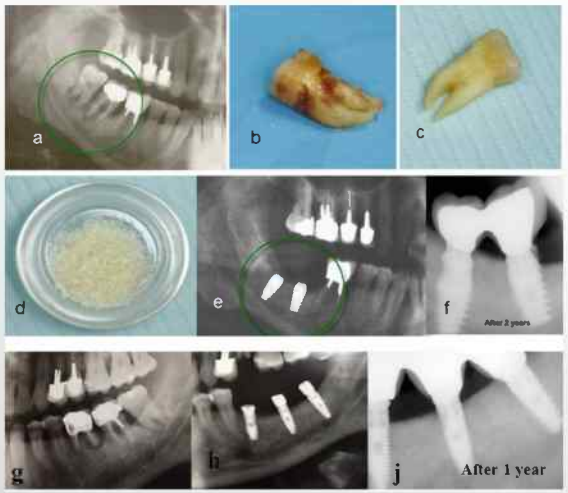


N°OF PATIENTS	AVERAGE AGE	IMPLANTS FAILED	FROM	TO
250	50.8	2	SEPTEMBER 2009	AUGUST 2011



Clinical application of auto- tooth bone graft material. J Korean Assoc Oral Maxillofac Surg 2012;38:2-8. Park SM, Um IW, Kim YK, Kim KW

N°OF PROCEDURES	DURING	COMPLICATION
100	2 YEARS	0



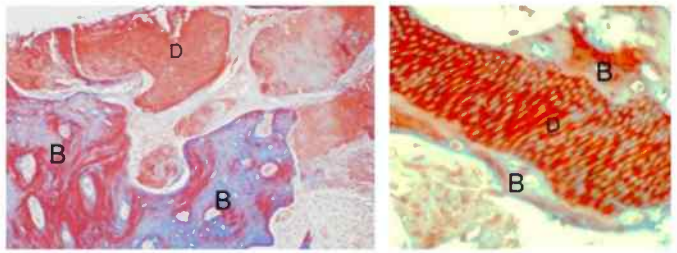


Figure 7: A histology section (Trichrome stain) of a core of bone tissue that was drilled out from upper jaw 3 month after grafting with autogenous dentin (a). A higher magnification of dentin-bone interface (b).Observe that dentin with its tubules (D) is surrounded by newly formed bone matrix (B).

The basic alcohol cleanser consists of 0.5M of NaOH and 30% alcohol (v/v), for defatting, dissolving all organic debris, bacteria and toxins of the dentin particulate

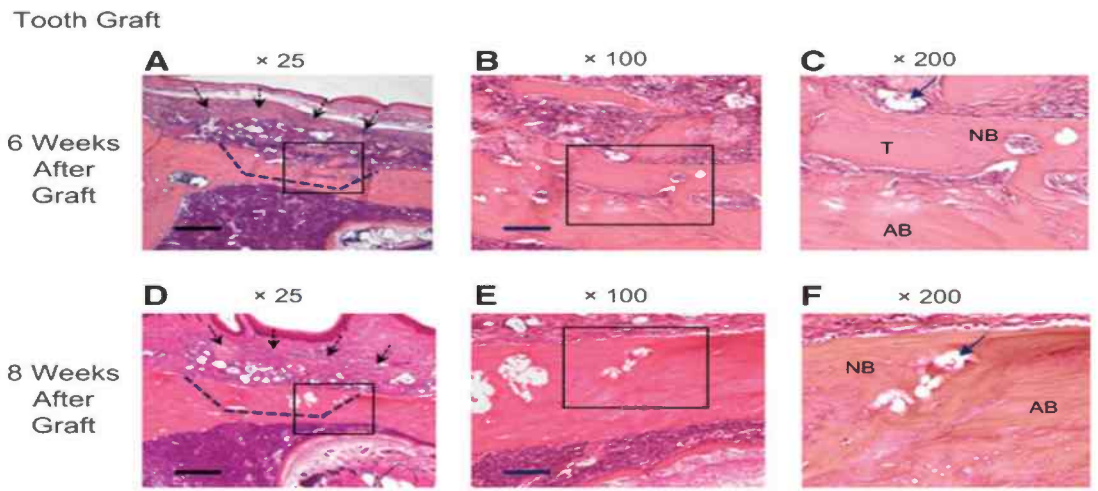
After decanting the basic alcohol cleanser, the particulate is washed twice, in sterile phosphate buffered saline (PBS)

the wet particulate can be put on a hot plate (140◦C) for 5 minutes and the dry bacteria-free particulate autologous dentin

A NOVEL PROCEDURE TO PROCESS EXTRACTED TEETH FOR IMMEDIATE GRAFTING OF AUTOGENOUS DENTIN
I.BINDERMANN, G.HALLEL
J INTERDISCIPLINAR MED DENT 2(6)1000154 2014

SIXTY MALE WISTAR RATS

HISTOLOGY AND M-CT SHOWED THAT NEW BONE WAS FORMED AND REPLACED WITH TIME (AT 6 AND 8 WEEKS) AFTER EXTRACTED TOOTH GRAFTING AND THAT THE DENTIN WAS IN- CORPORATED INTO THE NEW BONE



A NEW METHOD FOR ALVEOLAR BONE REPAIR USING EXTRACTED TEETH FOR THE GRAFT MATERIAL
T.NAMPO, J WATAHIKI, A ENOMOTO
J PERIODONTOL 2010;81:1264-1272.

20 RATS

GROUP 1	TOOTH GROUP
GROUP 2	ILIAC BONE
GROUP 3	NO MATERIAL

A New Method for Alveolar Bone Repair Using Extracted Teeth for the Graft Material

Tomoki Nampo,* Junichi Watahiki,* Akiko Enomoto,

J Periodontol 2010;81:1264-1272

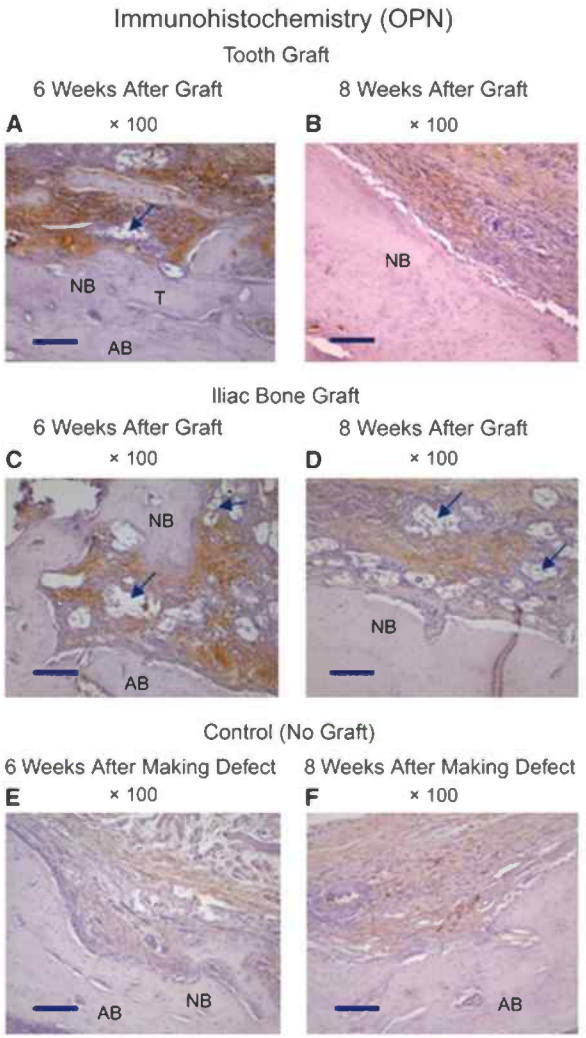
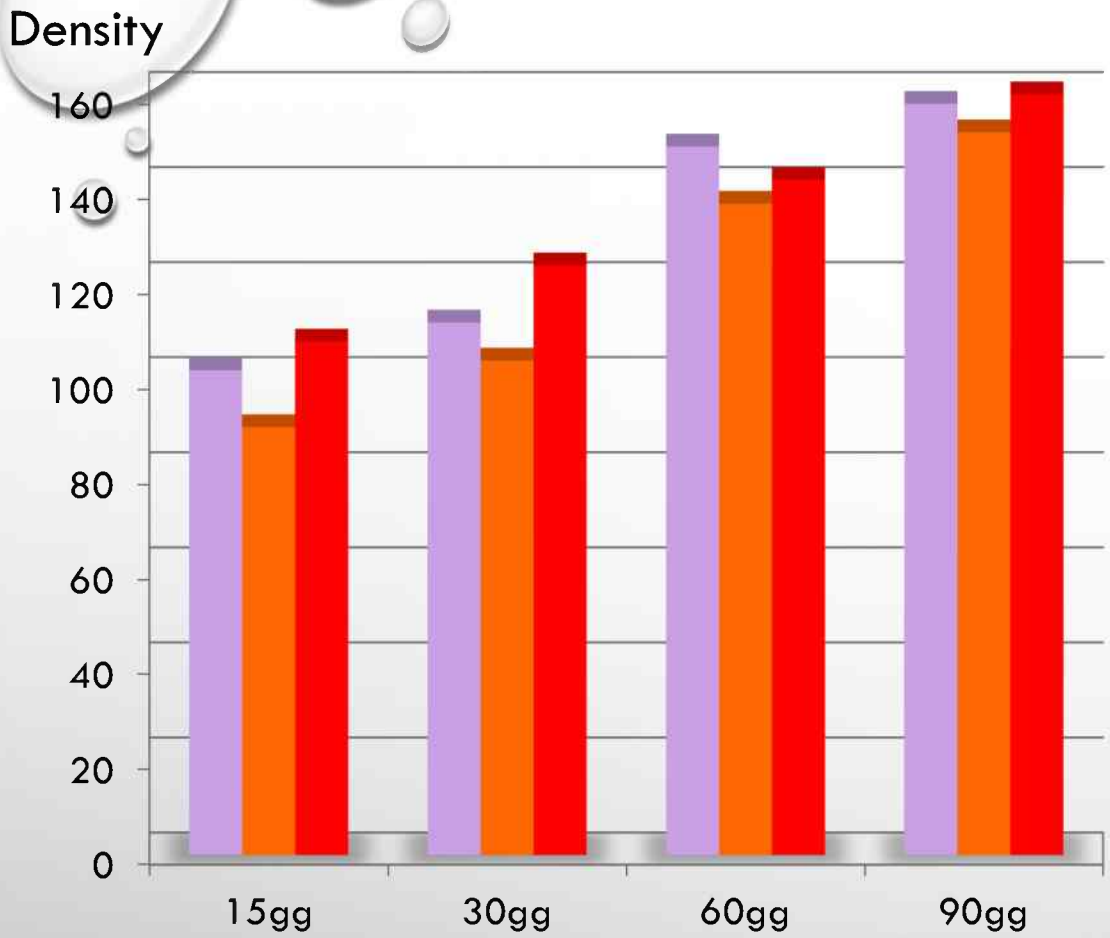


Figure 5.
*Comparison of immunohistochemical observation for OPN. **A** and **B)** Tooth graft; **C** and **D)** Iliac bone graft; **E** and **F)** Control (no graft). T = tooth; AB = alveolar bone; NB = new bone; arrowheads = β-TCP; blue scale bar = 25 μm (H&E, original magnification × 100).*



14 PATIENS
27 DENTAL SOCKETS

DENSITOMETRIC ANALYSIS OF THE AUTOGENOUS DEMINERALIZED DENTIN MATRIX ON THE DENTAL SOCKET WOUND HEALING PROCESS IN HUMANS
MÔNICA FERNANDES GOMESI; PAULA PINHEIRO DE ABREUII; ALINE ROSE CANTARELLI MOROSOLLI
BRAZ ORAL RES. VOL 2.4 SAO PAULO OCT/DEC 2009

VERTICAL GBR

FROM	TO	N° PATIENTS	AVERAGE AGE	N°OF IMPLANTS	SURVIVAL RATE
MARCH 2009	APRIL 2010	9	49.88±12.98	27	96%