

LONGITUDINAL CLINICAL STUDY ON THE EFFICACY OF OSSEOINTEGRATED DENTAL IMPLANTS IN PARTIALLY EDENTULOUS KOREAN PATIENTS : AN 8-YEAR PROSPECTIVE STUDY

Dong-Hoo Han, D.D.S., Ph.D., Hanna Eun-Kyong Bae, B.D.S.

Department of Prosthodontics, Oral Science Research Center, College of Dentistry, Yonsei University

This study was to evaluate the clinical evidence for the success and the predictability of the osseointegrated dental implants in the partially edentulous Korean patients. 201 patients have received total of 502 Brånemark implants, which were restored with either single or multiunit fixed superstructures at the Implants Clinic, Yonsei University Dental Hospital. The clinical and radiographic evaluations carried out on the patients for maximum 8 years were assessed annually for peri-implant inflammation, implant mobility (PTV), Plaque Index (PI), Gingival Index (GI), Bleeding on Probing (BOP), Keratinized Mucosa width and any changes in the surrounding bone level. The radiographs were taken at completion of the restoration, and annually thereafter. On the last recall appointments the patients filled a questionnaire consist of 29 questions in four categories. The cumulative non-failure rate of success was 93.9%. The first year mean bone loss was 0.3mm and less than 0.2mm annually thereafter. The periodontal parameters, keratinized tissue width and periotest values stabilized after initial changes in the first few years. The questionnaire has shown general satisfactory responses in all four aspect of dental implants treatment, including chewing efficacy, comfort, aesthetics and speech. The results support the predictability and success of the long-term rehabilitation of implant supported prostheses in partially edentulous Korean patients.

Numerous Long-term studies of osseointegrated implants have been carries out with highly successful outcomes. The current and the past long-term studies report cumulative success rate of 97% to approximately 80% in less successful results.^{1,2} If these long-term studies were somewhat limited to standard Brånemark in the past, they are now no longer limited in implant type,

site, bone type, prostheses type and many other variations.^{3,4} These reflect how much implant dentistry have advanced and become a part of routine dental treatment with diverse usage. This statement is true in European and North American population and all over the world. However these previously reported long-term studies are only found in the population groups stated. Many of these reports have been accepted widely as the gold

standard in representing the success rate of the implants being placed despite the differences in ethnic population. With out any dispute that with differences in the diet, skeletal structures and soft tissue characteristic the effect of stress on the dentition will vary, this implies that stress environment for the implants replacing the lost dentition will be also different. Brachycephalic facial skeletal shape of Korean which are in-between Northern Chinese and Japanese have been documented however there are no scientific evaluation on the bone quality, masticatory habit, dietary differences on the Korean to other Asian population or Caucasian population.⁵ Although the major dietary substances differ to other Asian population clinically it has been known that the highly fibrous Korean diet demands substantial occlusal and lateral forces during function. It is only therefore just to carry out long-term success rate of the implant treatment in Korean patients who represent some difference in oral environment.

To further the clinical evaluation of the implant treatment, a survey was carried out to evaluate a subjective assessment of the treatment by the patients. This was additional evaluation to clinical evaluation with strict criteria. The satisfaction which patient feels are the true success to the patients whatever the clinical evaluation would be.

The purpose of this study was to collect objective clinical evidence and subjective evaluation through the questionnaire by the patients, to evaluate success and predictability of osseointegrated dental implants in partially edentulous

Korean patients.

MATERIALS & METHODS

A total of 502 implants were inserted in consecutive 201 patients at Implant Clinic, Younsei University Dental Hospital from January 1993 until January 2000 accordance to the standards protocol described.²⁸ A single clinician carried out the prosthetic treatment of all patients and the review evaluation was carried out by the same clinician and trained doctors to standardize the evaluation. There was no specific patient selection but have accepted all the patients who were fit to have been treated for partially edentulous ridges on canine and posterior to this site, with Branemark implants. The mean patients age was 45.5 years (between 18 to 68 years) and implant to age distribution is shown in Table I. Greater proportion of female 57%(114 patients), was noted. Of 502 implants 154 implants were inserted in maxillar and reaming 348 implants in the mandible. 330 implants were placed in the molar regions. Table II. The reviewed duration of implants were from minimal of one year to 8years in function with prostheses and the average length of the review, was 3years. The selected patients underwent last review appointments for clinical and radiographical examination between May2000 to April 2001.

Each patients were given a recall appointments on 6monthly for initial two years and then annually thereafter. For a consistent collection of the data only annual review data were collected and

Table I. Gender and age distribution

	<20	20-35	36-50	51-65	>65	Sum
Female	2	28	51	29	4	114
Male	-	19	28	33	7	87
	2	47	79	62	11	201

Table II. Location of fixture

	Canine	Premolar	Molar	Sum
Maillar	18	67	69	154
Mandible	20	67	261	348
sum	38	134	330	502

used. On the day of the connecting superstructures and on each review appointments, clinical evaluation was made and radiographs were taken of the implants using parallel long-cone technique. An evaluation form was made and completed at each time. This had lists of clinical observation that was required to make to produce a consistent clinical data. The evaluation criteria were modified from that of Albrektsson et al⁶ described in 1986 to include GI, BOP, PI and the width of keratinised tissue was measured on both lingual and buccal of mandibular implants restoration and only on the buccal aspects on the maxilla. The stability was assessed at each appointment by removal of prostheses and used periotest (Siemens AG, Bensheim, Germany). Verbal confirmations on any pain or problems that may have been noticed by the patients were recorded on the evaluation sheet. Any changes in the marginal bone level or presence of peri-implant radiolucencies were noted from standardized radiographs. All the radiographs of all the implants reviewed were scanned and measured for the marginal bone level. The known length in this study was measurement of five threads on the implants and longitudinal measurements of both mesial and distal implant margins to bone contact were measured from a reference point, abutment-fixtured junction on the implants. The values were then applied to a formula described by Manz⁷ and the level of the bone was measured. To minimize the error of operator, one person carried out all the radiographic measurements. The values were added and divided to obtain the average values.

The questionnaire consisted of 29 questions which can be categorized into four types of questions; comfort, chewing ability, speech and aesthetics. Details of the questions are as on Table I. Each question answers were divided into five different categories in which patients could indicate, as they felt most appropriate.^{8,9} This enables choice of broad spectrum of answers, and simple

Table III. Type of questions on Questionnaire

Comfort
on prostheses
discomfort intraorally since connection of prostheses
episodes of check or tongue bite
altered sensation or facial pain
episodes of swellings or infection
food impaction
Aesthetics
able to smile and face public
self-confidence with appearance
satisfaction with colouration and shape of prostheses
Speech
difficulties in pronunciation and specific examples in Korean
Chewing
satisfaction with ability to chew food in general
ability to chew specific foods 8 examples

interpretation and analysis of the questionnaire. Patients attending review clinic from November 2000 until April 2001 completed the questionnaire. Table III.

RESULTS

Life table

In 8 years 502 implants were placed and reviewed annually of these 15 known failure have been accounted. 6 implants were lost prior to the delivery prosthesis, four in the first year of the delivery prosthesis and five on the second year of delivery as shown on the life table. There were total of 12 failed implants with diameter of 3.75 with greater number with shorter in length. Table IV. The proportions of the failed implants were similar in the both mandible and maxilla, 8 and 7 as correspond. During the review one person died, representing three implants on the third year. The table V shows the cumulative non-failure rate, was 93.9% by the end of 8year review.

When closer examination was made, the table reveals a large proportion of the drop out as patients failed to attend the review clinics despite efforts from the Implants clinic and only 56%

implants were regularly followed up on the review clinics.

Mild complications

During the clinical review, mild complications were observed. On removal of the prostheses routinely, there was 36 cases of screw loosening could have been observed with greater number of occurrence in the multi- united prostheses than the single restoration. In the first and second

Table IV. Diameter and length of failed implant

3.75*10	4	5.00*10	1	Lower posterior	8
3.75*13	4	5.00*13	2		
3.75*15	3			upper posterior	7
3.75*20	1				

Table V. Life Table Presentaion of Reviewed Patients

	No. implant at Start (no. patient)	not yet elapsed (no. patient)	Drop out (no. patient)	failure (with only failure/with surviving implants)	deceased	Annual failure rate(%)	Annual non failure rate(%)	cumulative non failure rate(%)
year	502							
Abutment connection	496(193)			6(2/4)		1.2	98.8	98.8
1	394(161)		97(30)	4(2/2)		1	99	98
2	261(107)	51(21)	77(32)	5(0/5)		1.9	98.1	97.7
3	139(56)	104(38)	18(12)		3(0/ 1)drceased		100	95.7
4	73(32)	56(20)	10(4)				100	95
5	45(19)	20(9)	8(4)				100	94.6
6	26(10)	14(9)	5(3)				100	94.3
7	11(4)	13(5)	2(1)				100	94
8	7(2)	4(1)					100	93.9

Table VI. Mild complications reported during the follow-up period

Type of complication	Del.	1st yr	2nd yr	3rd yr	4th yr	5th yr	6th yr	7th yr
Screw loosening		12 (ms:9/mc:3)	11 (ms)	11 (ss:1/ms:10)	1 (sc)			1 (ms)
Screw bending		1 (ss)	2 (ms)					
Screw fracture						1 (ms)		
Fixture fracture				1 (ms)				
Porcelain or resin fracture		4 (ms:3/sc:1)	2 (ms)	1 (ms)	2 (ms)		1 (ms)	1 (ms)
Cement washout					1 (sc)			
Infection		1 (ms)	1 (ms)		1 (sc)			
Adverse psychological reaction		3 (ms)						

ss : single screw type
 sc : single cement type
 ms : multiple unit screw type
 mc : multiple unit cement type

year, bent screws were observed, single episode of screw fracture on the fifth year and fracture of superstructures in every year except on the fifth year. There were episodes of gingival infections and adverse psychological reaction by patient representing three implants to implant treatments. Through out the review period no serious complications such as anesthesia, parathesia, and alteration of facial sensation or facial pain were reported. Table VI.

Soft tissue evaluations

Measurement to evaluate soft tissue health, GI, PI, BOP and widthness of keratinized mucosa contiguous to the implants were made. The GI, PI, and BOP values increased slightly in the first three years from 0.08 to 0.13 in GI, 0.45 to 0.66 in PI and 0.45 to 0.54 in BOP. All three indices had a large standard deviation but it remained constant in values. As graphs indicate the lower values of the first year deteriorates in the following years. This could be found in all three indices. (Fig. 1) The keratinized tissue widthness changes were also represented as graph. (Fig. 2) The largest average value was at lingual of mandible and the lowest was at buccal of mandible at initial examination. Generally the largest in each area was at the first measure-

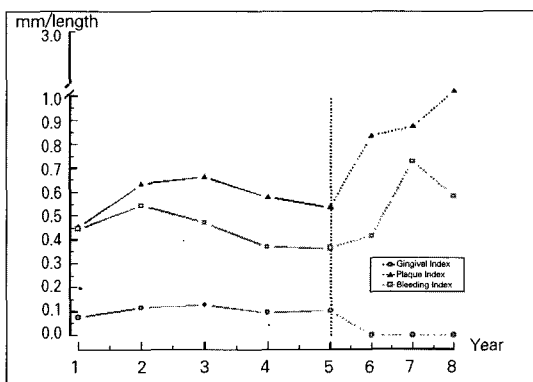


Fig. 1. Annual changes of indices

ment, connection of superstructure and they were 2.78, 2.28 and 3.21 on buccal side of maxilla, buccal side of mandible and lingual side of mandible respectively. This shows a general trend in reduction in the keratinized tissue widthness with increase in duration since connection of superstructure.

Stability Test

The tooth mobility in this clinical study was carried out in all the implants review and at every recall appointments. The average value of the periotest at delivery of superstructure was -4.51 ± 2.61 . There was linear decrease in PTV to -5.49 ± 2.61 at the third year and stabilized at this value for the remaining duration of review with little deviation. (Fig. 3) The changes in the values were statistically tested using paired t-test. The first and second year values were $p=0.00$ and $p=0.01$ respectively and they were statistically significant. On the third and fourth year the values were $p=0.55$ and 0.39 and they were statistically not significant.

Radiographic evaluation

The result of averaged values of each year of review was represented on the graph. (Fig.4) On the first year the mean marginal bone loss was 0.3 ± 0.08 mm On the following years the average

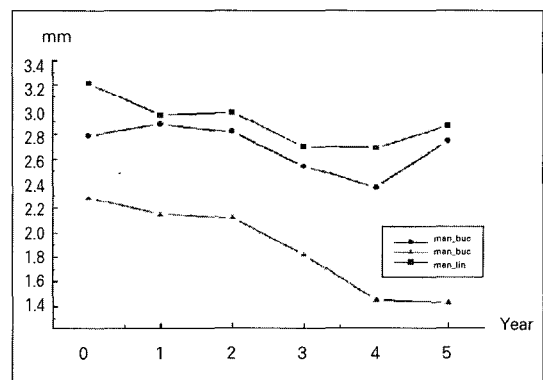


Fig. 2. Annual changes the width of keratinized tissue width

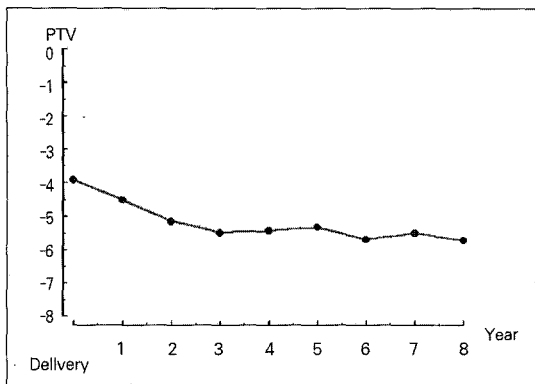


Fig. 3. Annual changes in periosteal values

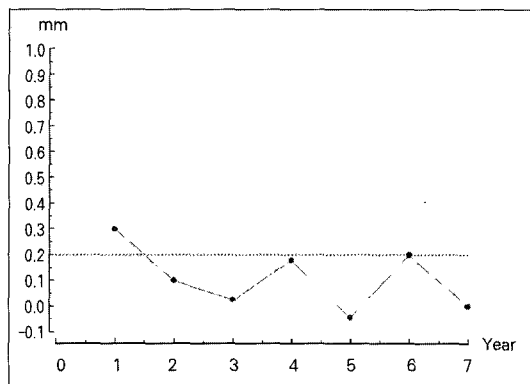


Fig. 4. Annual changes in marginal bone loss

Table VII. Four Field Table

Success grade 1&2 46% (n=232)	unaccounted for 46% (n=232)
Surviving 7.5% (n=38)	Failure 3% (n=15)

annual marginal bone loss were less than 0.2mm. The values were 0.1 ± 0.07 mm, 0.025 ± 0.05 mm and 0.18 ± 0.13 mm on the second, third year and fourth year of marginal bone losses. However all the values were statistically insignificant. The reliability on the values after fifth year is questionable as the sample size is too small to represent the values.

Four Field Table

All the results of both soft tissue evaluation, clinical complication, stability test and the radiographical evaluation of each implants over the reviewed period were cumulated together and each implant was classified in three grades of success, survival, failure and unaccounted. Each Category is based on the classification described by the Roos et al.¹⁰ however for the stability test, PTV was used in place of the manual mobility test and any zero or negative value was used as acceptable in this evaluation for grade 1 in mobility test. This is represented on the Four Field

Table. Table VII. Unlike the values of Roos et al, most of the implants were tested for stability and there was less number of the implants in the second category of success. This has shown that 46.2% of the implants were success but as described earlier large proportion of the implants, 43.2% were unaccounted for and 7.6% were surviving and 3% represented by failed implants.

Survey

The Questionnaire filled by the patients does not represent all the patients who were reviewed on regular recall appointments. However, latter six month of the reviewed patients were all asked to fill the questionnaire and the results were grouped into four types of questions and were represented as charts. Full 100% satisfaction was noted in the speech (Fig. 5) but as the restorations were mainly on the posterior area, the patients may have noted a little difference. The comfort, aesthetics (Fig. 12) and chewing ability were all favored for the implant treatment. In evaluation of comfort (Fig. 6), 87% of patients felt excellent or good were comfortable with prosthesis but approximately 3% of patients felt uncomfortable. In specific to food impaction, 21% claimed of no discomfort or history from food impaction, 41% had acceptable food impaction but 38% had heavy food impaction. The chewing

ability(Fig. 7) represents sum of responses of all the eight different types of Korean food where each food had different texture and hardness. On the

specific food type, even when the food is highly demanding on masticatory function and force where the patients have been advised not to

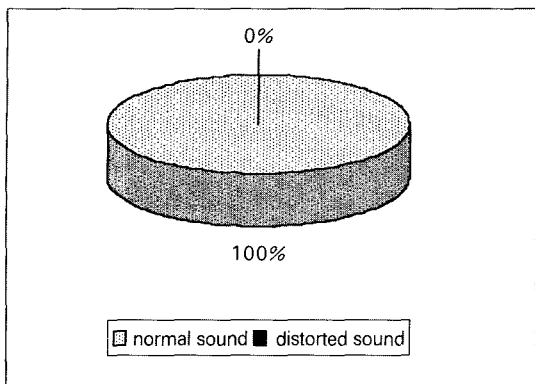


Fig. 5. Speech

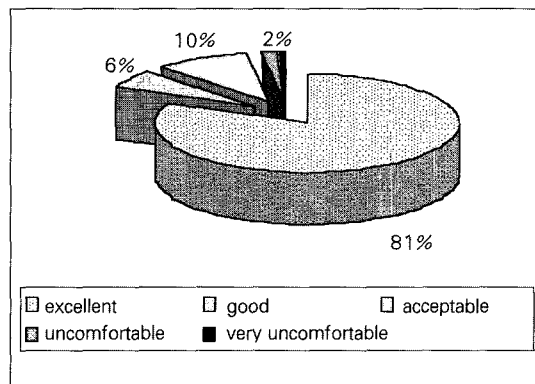


Fig. 6. Comfort of Prosthesis

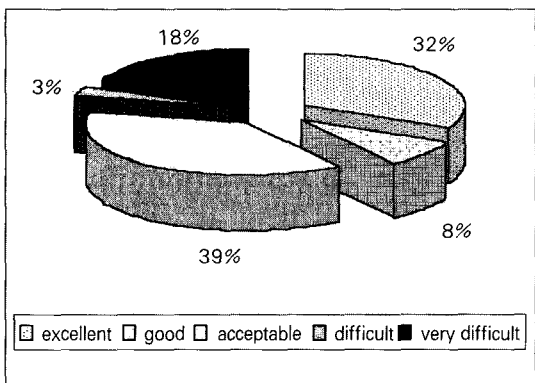


Fig. 7. Chewing Ability

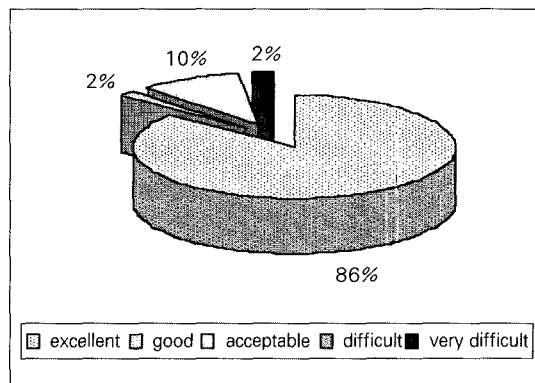


Fig. 8. Chewing Ability on Specific Food(Kimche-vegetable)

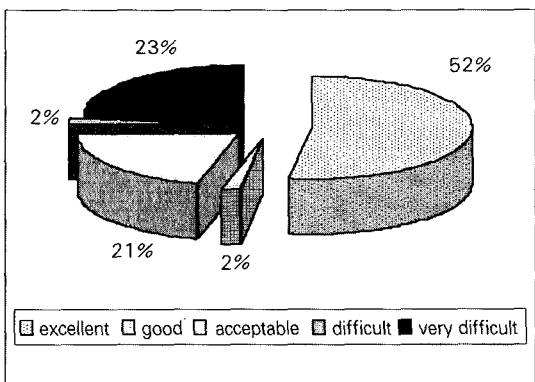


Fig. 9. Chewing Ability on Specific Food(Dried Squid)

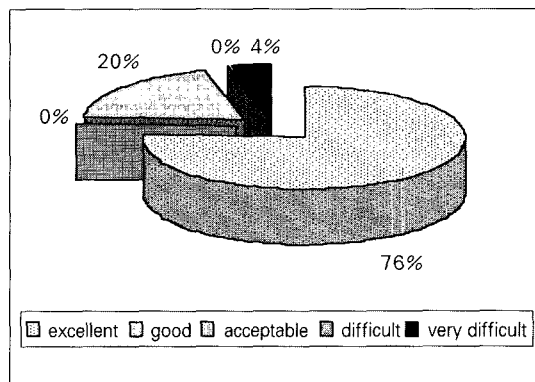


Fig. 10. Chewing Ability on Specific Food(peanut)

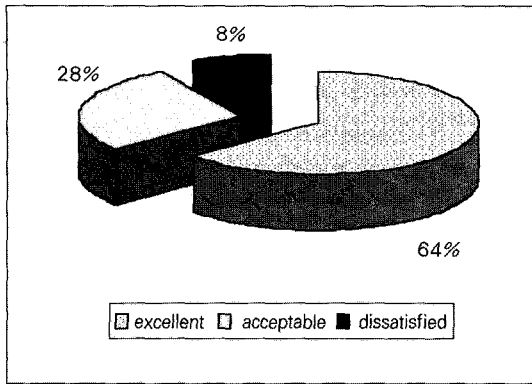


Fig. 11. Aesthetics

chew such as dried squid fish, the patients still had these food and found improvements in chewing. (Fig. 8 ~ 11) On specific food responses more than half of the patients were excellent or good masticatory function. The highest satisfaction on chewing was with Kimche, a vegetable dish, with 88% good or excellent chewing and lowest with 54% in dried squid fish.

DISCUSSION

Numerous authors have documented longitudinal studies in the implant treatments and representation of the information in each study may not be consistent with others to make a healthy comparison and to obtain scientific information. Guide to this field of science could be taken from several literatures. The American Dental Association describes clinical, radiographical and patient parameter should be combined in evaluation. Albrektsson 1998¹¹ states that for a correct scientific reports one should have a good sample size of minimum 50 implants and advisable to carried out in a multi-center studies with a supervisor to sustain a constant evaluation standard in each centers. The article addresses the limitation of use in lifetime table. This can misrepresent the success rate in a cumulative non-failure rate, which in truth is a survival rate rather than a success rate. To jus-

tify an implant for a success it should be examined in strict success criteria and often this is not carried out.

This study is carried out in a single -center with one operator to deliver the prostheses. This obviously has advantage in producing a constant standard but has limitation in that the bias of single operator and center is present in the study.

After healing of the surgical procedure, the biological seal will form around the neck of the implants, that of functional epithelium, 1-1.5mm and connective tissue region which is superior to alveolar bone, 1.5-2mm¹² The health of marginal gingival ultimately affects the marginal bone level and prognosis of implant.¹³ The criteria used in this study was based on those described by Albrektsson 1986⁶, but elaborated further by carrying out detailed examination of gingival using GI, PI and BOP evaluation on each implant. Behneke et al¹⁴ have stated that there was no soft tissue parameter correlated with prognosis of implants. Severe inflammatory observations have not been observed on the previous journals. Although the changes in the gingival indices have deteriorated after first three years, this may have been influenced by the patients' own lack of oral hygiene care rather than any other factors and in a shorter period, similar observation of increase in soft tissue indices were observed in Behneke.

The Plaque formation around the implants can be affected by the implant surface type and prosthesis. Remandini et al¹⁵ showed that in 24 hours there was significantly high proportion of plaque adhesion but Quirynen¹⁶ indicated that after third month, there was little variation in the composition of the microorganisms.

Keratinized gingival thickness was also evaluated. With keratinized tissue, the values have gradually decreased. Although the value of mandibular buccal area was less than other sites the rates were similar on all the sites. The increase in the val-

ues after third year may be invalid as the sample size is small.

In Osseointegration of implants the bone undergoes three different stages; formation of woven bone, adaptation of lamellar and parallel fibered bone deposition and finally functional adaptation which continues for the rest of life.¹⁷ The latter, the dynamic modeling of the bone allows the maintenance of implants in long term through communication with osteocytes and osteoblasts in response to changes in the environment especially the masticatory force.¹² The degree of true osseointegration cannot be physically measured without histological evaluation. This is not feasible in patients and stability test and radiographic examination are often used in substitute. Other methods also have been described with varying in its accuracy.

The stability test in Albrektsson¹¹ has measured macro-movements when the inter-observer varied greatly reducing its reproducibility. There have been journals, which voices stability test using periotest is inappropriate due to its inaccuracy. This has been disputed with more quantifiable method of detecting stability, especially in a long-term study with its high repeatability.¹⁸ In this study PTV have been used in evaluating and the values of the PTV becomes gradually more negative. Which is similar to that of Behneke.¹⁴ However, a correct orientation of the instrument is vital in its accurate measurements.¹⁹ As the implants functionally adapted, in gross term ankylosis to alveolar bone and its bone remodeling over years may have been represented as greater osseointegration.^{20,25} In PTV with increase in the osseointegration the value is more negative as the duration of the contact between the restoration and the periotest tip is short thus more negative in its value. Therefore may indicate degree of success of the implant osseointegration.

The radiographic examination and measurements were as represented on the graph. It would seem

that the result of first three years are again more true representative of the implants due to the sample size. The first few years have shown a gradual decrease in the values of bone loss. In a detailed examination of the each value, the increase in the marginal bone loss values in two occasions fourth and sixth year were from single implant with increased bone loss in a small sample size which therefore have been affected by the value greatly. Meijjer²¹ has stated a large standard deviation with its best accurate method, use of sliding gauge. Which has been also reflected in this study. The explanation of difficulties in determining accurate level of marginal bone around the implants was given. Benn on the other hand does not account any of currently available methods were sensitive enough to measure bone changes less than 1 mm. The most recommended effort however stands with standardized radiographic technique and use of large sample size. The result however was within the limits of success criteria of Albrektsson.

It is known that the marginal bone level changes prior to and after connection of superstructure. This has been noted that the changes are not only in the vertical direction and others have measured horizontal and area of bone loss.²⁷ Due to this loss in the bone the soft tissue can be affected and the interpapillary tissue quantity and quality can change depending on the support. This can be reflected on the survey response to food impaction. In soft tissue evaluation Behneke¹⁴ disputed this but many others states otherwise. Therefore it would have been interesting to review the changes in food impaction against time, interdental space and type of structure adjacent to the implants, whether it is natural dentition or implants.

As described by Albrektsson 1998, the true success criteria of implants require a through evaluation of the implants must be made and each implants classified for its success or failure. Buser et al²² when applied the lifetime table in a large

sample size a successful interpretation of the information could be achieved. However a lifetime table can often be misleading and even in our study over 90% of cumulative survival rate has been obtained with high level of unaccounted patients. To produce data for four field table, each implant evaluation of soft tissue, discomfort and radiographs were made the each implant evaluation over the review periods were summoned together for classification as done in Roos et al.¹⁰ In the evaluation of the other studies final restorations were rarely removed and tested for its mobility or stability. There was small quantity of class 2 implants and the success rate of 46.2%. It is great misfortune to have such a high level of incompliance, which, is a characteristic of Korean dental patients regarding follow up appointments. It must be emphasized that these patients attending the University Dental Hospital may be more dentally aware than average population and with additional effort from staff members of implant clinic have achieved 57% recall rate. This is an inadequate for a healthy reference to success of implants but this can act as guiding point to future studies with larger sample size, different implant system and higher proportion of patient attendance for recall appointments.

Patient satisfaction of osseointegrated dental implants have been studied and reported in the past with a positive responses and substantial improvements on the function and well being of patients were noted.^{23,24,26} In the current study, high patient satisfaction level corresponded with results of other studies despite the differences in many dietary and anatomical variations. Detailed patient information collected in the Clancy et al²³ indicated significance of patient expectation and lack of discomfort to patient satisfaction level. In Zarb et al²⁴, only verbal confirmation was made and recorded. However this study has carried out detailed investigation in the masticatory function and the satisfaction level which

was in favourable outcome even with the most demanding environments.

CONCLUSION

The objective clinical result of this prospective longitudinal clinical study and responses of questionnaire of partially edentulous Korean patients treated with implant-supported prostheses indicate a favorable outcome.

The cumulative non-failure rate was 97% however, the four field tables shows that the success in implants were 46.2% in 8 years of review, as there was high proportion of unaccounted patients in this prospective study.

Patient satisfaction rate obtained from the questionnaire indicate general satisfaction with implant treatment.

This investigation was supported in part by Yonsei University Research Fund of 2001.

REFERENCE

1. Friberg B, Nilson H, Palmquist C. MKII: the self-tapping Brånemark implant: 5-year results of a prospective 3-centre study *Clin Oral Impl Res* 1997;8:279-285.
2. Becker W, Becker B E, Abdulaziz Alsuwyed, Sultan Al-Mubarak. Long-term evaluation of 282 implants in maxillary and mandibular molar positions: a prospective study. *J Periodontol* 1999;70:896-901.
3. Lekholm U, Gunne J, Hery P et al Survival of the Brånemark implants in partially edentulous jaws: A 10-year prospective multi-center study *Int J Oral Maxillo Implants* 1999;14:639-645.
4. Jemt T, Lekholm U. Oral implant treatment in posterior partially edentulous jaws: a 5-year follow-up report. *Int J Oral Maxillofac Implants* 1993;8:635-640.
5. Koh K S, Shon H J, Rhee E K et al Anthropological study on the facial flatness of Korean from the-historic to themodern period *Korean J Physical Anthropol* 1999;12:211-221.
6. Albrektsson T, Zarb G, et al The long-term efficacy od currently used dental implants: A review and proposed criteria of success *Int J Oral Maxillo Implants* 1986;1:11-25.
7. Manz MC. Radiographi assessment of peri implant verticla bone loss: DICRG interm report

- no.9 J Oal Maxillofac Surg 1997;55:62-71.
8. Kent G, Jhons R. A controlled longitudinal study on the psychological effects of osseointegrated dental implants Int J Oal Maxillo Implants 1991;6:470-474.
 9. Goldberg D P, Rickels K, Downing R, Hesbacher P. A comparison of two psychiatric screening test. Brit. J. Psychiat 1976;129:61-7.
 10. Roos J, Lekholm U, Jemt T, Grondahl K, Albrektsson T. A qualitative and quantitative method for evaluating implant success: A 5-year retrospective analysis of the Brånemark implant. Int J Oral Maxillofacial implant 1997;12:504-14.
 11. Albrektsson T, Zarb G A. Determinants of correct clinical reporting. Int J Prosthodontics 1998;11:517-21.
 12. Stanford C M. Biomechanical and functional behaviour of implants Adv Dent Res 1999;13:88-92.
 13. Adell R, Lekholm U, Rockler B, Brånemark PI A 15-year study of osseointegrated implants in the treatment of the edentulous jaw. Int J Oral Surg 1981;10:387-416.
 14. Behneke A, Behneke N, d' Hoelt B, Wagner W Hard and soft tissue reactions to ITI screw implants: 3- Year Longitudinal Results of a Prospective Study Int J Oal Maxillo Implants 1997;12: 749-757.
 15. Rimondini L, Fare S, et al The effect of surface roughness on early in vivo plaque colonisation on titanium. J Periodontol 1997;68:556-562.
 16. Quirynen M, Bollen CM et al The influence of titanium abutment surface roughness on plaque accumulation and gingivitis: short-term observations. Int J Oral Maxillofac Implants 1996;11:169-178.
 17. Schenk R, Buser D. Osseointegration: a reality Periodontology 2000 1998;17:22-35.
 18. Truhlar R S, Lauciello F, Morris H F, Ochi S. The influence of bone quality on periosteal values of endosseous dental implants at Stage II /surgery J Oal Maxillofac Surg 1997, Suppl 5; 55:55-61.
 19. Chavez H, Ortman L F, DeFranco R L, Medige J Assessment of oral implant mobility J Prosthet Dent 1993;70:421-6.
 20. Drago C J. A prospective study to assess osseointegration of dental endosseous implants with the periosteal instrument Int J Oal Maxillo Implants 2000;15:389-395.
 21. Meijer H A, Steen W H A, Bosman F A comparison of methods to assess marginal bone height around endosseous implants J Clin Periodontol 1993;20:250-253.
 22. Buser D, Mericske-Stern R, Bernard JP, Behneke N et al Long-term evaluation of non-submerged ITI implants Part 1; 8-year life table analysis of a prospective multi-center study with 2359 implants. Clin Oral Impl Res 1997;8:161-172.
 23. Clancy J M S, Buchs A U, Homayoun A. A retrospective analysis of one implant system in an oral surgery practice. Phase I: Patient satisfaction. J Prosthet Dent 1991;65:265-71.
 24. Zarb GA The longitudinal clinical effectiveness of osseointegrated dental implants in dental implants in posterior edentulous patients Int J Prosthodont 1993;6:189-196.
 25. Olive J, Aparicio C The periosteal method as a measure of osseointegrated oral implant stability Int J Oral Maxillofacial implant 1990;5:390-400.
 26. Ekfeldt A, Carlsson G E, Borjesson G. Clinical evaluation of single-tooth restorations supported by osseointegrated implants: a retrospective study. Int J Oral Maxillofac implants 1994;9:179-183.
 27. Tarnow D P, Cho S C, Wallace S S. The effect of inter-implant distance on the height of inter-implant bone crest J Periodontol 2000;71:546-549.
 28. Lekholm U. Clinical procedures for treatment with osseointegrated dental implants J Prosthet Dent 1983;50:116-120.

Reprint request to:

DR. DONG-HOO HAN
 DEPT. OF PROSTHODONTICS, ORAL SCIENCE RESEARCH CENTER, COLLEGE OF DENTISTRY, YONSEI UNIVERSITY
 134, SHINCHON-DONG, SEODAEMOON-GU, SEOUL, 120-095, KOREA
 Tel: 82-2-361-8940 Fax: 82-2-312-3598
 E-mail: donghooan@yumc.yonsei.ac.kr