CASE REPORTS OF ARTIFICIAL ROOT THERAPEUTICS

Ogawa, M.[1),3)], Okamoto, A.[2)], Kaku, T[3)] and Nishihara, K.[4)]

1) Asty Dental Clinic Asty 45 Bldg. 6F, N-4, W-5, Chuo-ku, Sapporo, Hokkaido, Japan
2) Okamoto Dental Clinic 22-8, Shinkawa, Hakodate, Hokaido, Japan
3) Department of Oral Pathology, School of Dentistry, Health Sciences University of Hokkaido 1757 Kanazawa, Ishikari-Tobetsu, Hokkaido, Japan
4) Nishihara Institute Hara Bldg.3F,6-2-5 Roppongi, Minato-ku, Tokyo, Japan

ABSTRACT

In this paper we show five cases of the artificial root therapeutics made of pure titanium invented by one of the authors, Nishihara. These five patients' ages ranged from 40 to 62 years of age. Artificial roots from two to ten per patient were implanted at the edentulous premolars and/ or molars of a mandible and/ or a maxilla. Appropriate biomechanical stimuli were continuously applied to the artificial tooth roots immediately after implantation with loose fixation instead of the conventional concrete fixation.
Radiographic examinations revealed a lamina-dura layer around the artificial tooth roots with a thin radiolucent space resembling that of the natural tooth. Two- to eight-year follow-up periods of these five cases revealed a good outcome after the artificial root therapeutics.

INTRODUCTION

Various types of dental implants made of titanium, and hydroxyapatite, with excellent biocompatibility, have been clinically used. For dental implants, there are two different functional systems related to the masticatory multiple forces. One is a micromoving system by gomphosis and the other is the fixed system of ankylosis[1-7)]. At present, optimal healing around dental implants is considered as having direct, intimate contact with bone tissue, i.e. osseointegration[8)]. However, since osseointegrated implants are ankylosed and do not have the same mobility as natural teeth with a periodontal ligament, efforts have been made for years to compensate for this obvious difference by shock absorbing systems built into the implant or its suprastructure[9,10)]. The tooth is attached to the jaw by a specialized supporting apparatus that consists of alveolar bone (alveolar process), the periodontal ligament, and cementum [11-13)]. The periodontal ligament is also supportive, suspending the tooth in the socket and providing a cusion against various occlusal forces. It also allows for tooth movement. Such movement stimulates sensory receptors in the periodontal ligament, so providing information on the loading and movement of individual teeth. From this point of view Nishihara et al. [5,8)] invented an artificial tooth root termed as the gompholic type made of dense hydroxyapatite, zirconium oxide, and titanium with functional support of collagenous peri-artificial fibers and collagenous anchoring.
In mammals the gomphosis type of attachment with a periodontal ligament may be associated with the increased stresses and strains brought to bear on the tooth during mastication[7,12)].

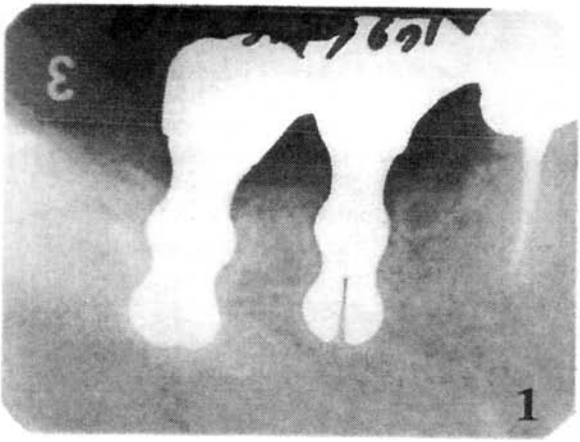
The artificial tooth root joined the jawbone with fibrous tissue resembling periodontal ligaments with cementoblasts and alveolar bone proper, forming osseous structures of lamina dura around the root[1~6]. In radiographic terms, it is reffered to as the lamina dura[13].

In this paper we report five cases of the artificial root therapeutics made of pure titanium invented by Nishihara[2,3]. Appropriate biomechanical stimuli were continuously applied to artificial tooth roots immediately after implantation with loose fixation instead of conventional concrete fixation. There are few reports elaborating on the periodontal ligament around dental implants[1~6,4].

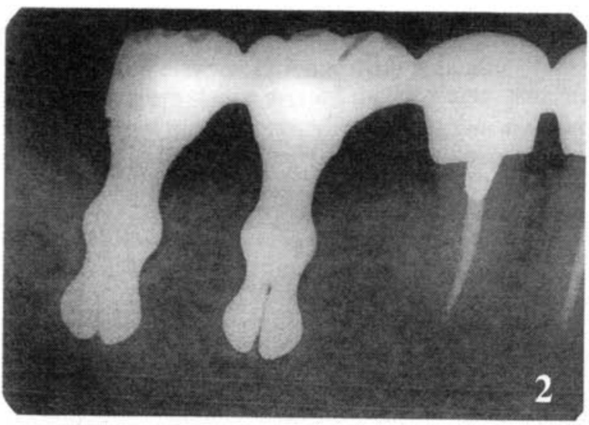
CASE REPORTS

1) Case 1: A 40-year-old male patient with defects of right mandibular molars
Dental X-ray photographs (Fig. 1)

Two years and 4 months after the implant replacement.



A thin opaque layer of bone like a lamina dura is seen around the implants. The lamina-dura-like appearance is clearly visualized on the mesial surface and poorly visualized on the distal surface and apex.



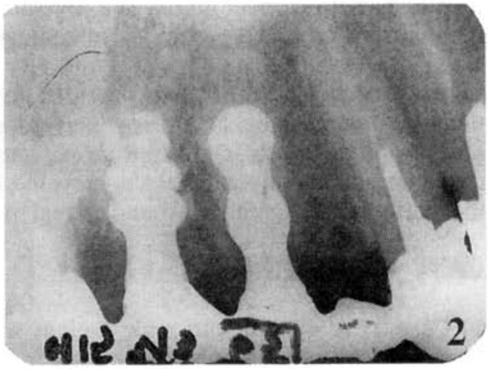
Three years after the implant replacement.

The lamina-dura-like appearance is poorly visualized on the distal surface of the implants at the second molar.

2) Case 2:A 62-year-old female patient with defects of right maxillary premolars.
Dental X-ray photographs (Fig. 2)

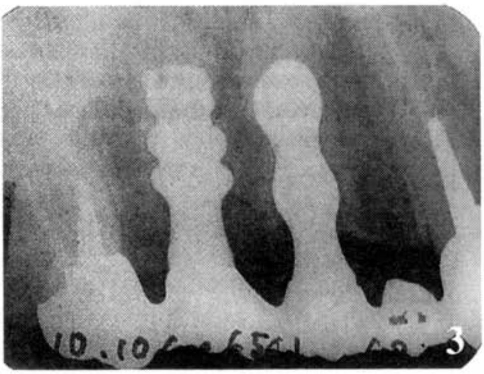
Just after implantation.

Two years after implantations.



The lamina-dura-like appearance is poorly visualized on the apex of the implant at the second premolar.

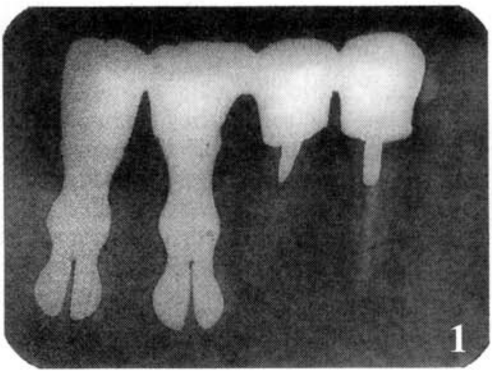
Seven years after implantation

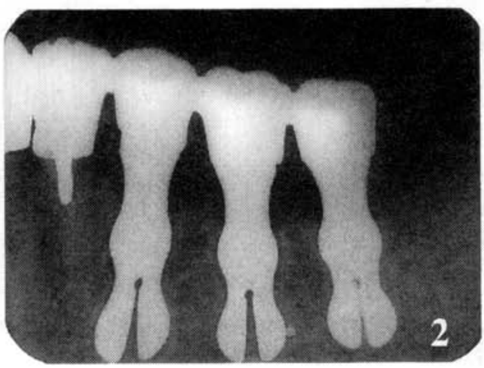


An radiopaque layer of bone like a lamina dura is wider and more dense around the implants. A radiolucent space like the periodontal ligament is poorly visualized.

3) Case 3: A 60-year-old female patient with defects of bilateral mandibular molars. Dental X-ray photographs (Fig. 3)

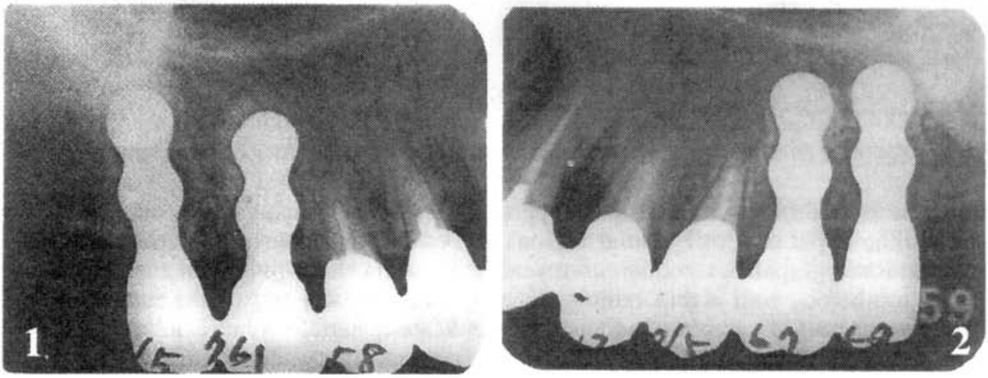
Two years after the implant replacement.



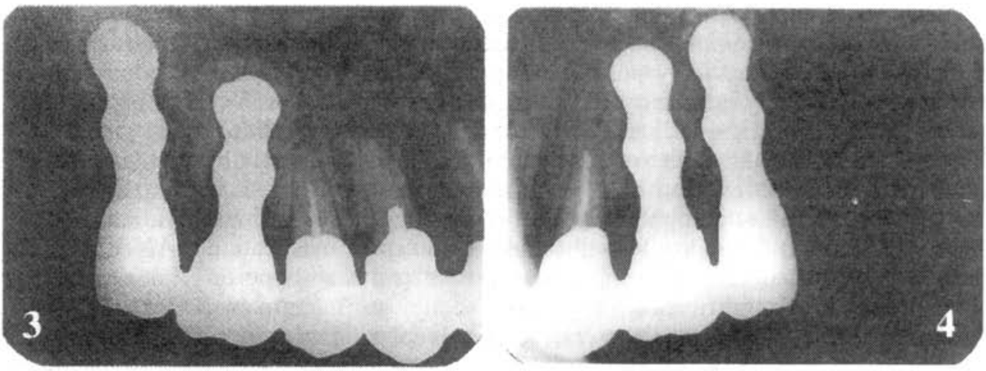


The lamina-dura like appearance is poorly visualized at the distal surface of the implants at bilateral second molars.

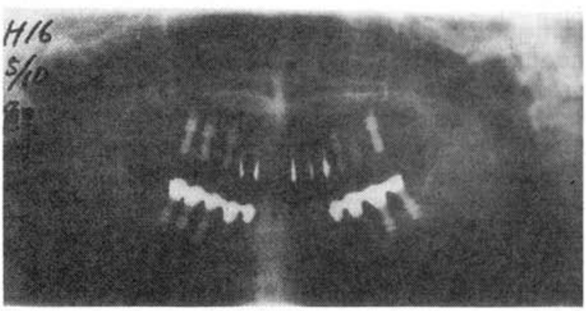
4) Case 4: A 51-year-old female patient with defects of bilateral maxillary molars. Detal X-ray photographs (Fig. 4)
One year and 3months after implantation



Four years after implantation.

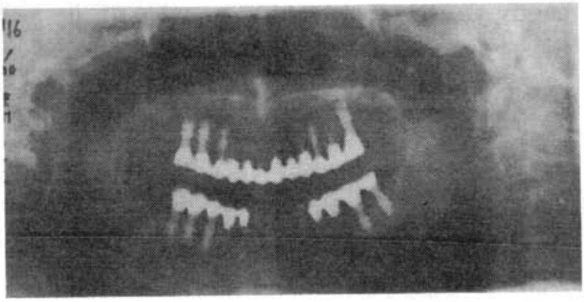


A thin opaque layer of bone like a lamina dura is seen around the implants. It is wider and more dense around the implants, particularly at the apex. The lamina-dura-like appearance is poorly visulalized. the periodontal ligament between the implant and the lamina-dura-like appearance is clearly observed.



5) Case 5: A 50-year-old female patient with defects of maxillary and mandibular premolar and molars.
Panoramic radiographs (Fig. 5)

The mandibular suprastrucures were seated five months after the mandibular implant replacement.



The maxillary suprastructures were seated one year after the implant replacement.

DISCUSSION

Artificial tooth roots of titanium were applied to five cases, such as free end edentulous cases in the upper and lower molar regions and edentulous cases in the upper premolar regions. Radiographic examinations revealed a lamina dura-like layer around the artificial tooth root with a thin radiolucent space resembling that of the natural tooth. Therefore, these radiographic findings might indicate favorable bone remodeling around roots under sufficient masticatory function. Two- to eight-year follow-up periods of these five cases revealed a good outcome after artificial tooth root therapeutics.
The use of dental implants has become a scientifically accepted treatment concept in dentistry to replace lost or missing teeth in fully and partially edentulous patients. This breakthrough in implant dentistry was initiated by the discovery that dental implants made of commercially pure titanium can be anchored in the jawbone with direct bone contact i.e. osseointegration [15]. Osseointegration has been commonly accepted as an ideal bonding system of artificial tooth root to the jawbone[8]. However, in mammals, teeth are attached to the bones of the jaw by tooth-supporting connective tissues consisting of cementum, periodontal ligament, and alveolar bone (alveolar process), i.e. gomphosis type of tooth attachment, which provide an attachment with enough flexibility to withstand the forces of mastication[7]. Alveolar processes are composed of the alveolar bone proper and the supporting bone. Alveolar bone proper is a modification of compact bone, as it contains perforating fibers (Sharpey's). These collagen fibers pierce the alveolar bone proper at right angles or oblique to the surface of the long axis of the tooth. This is the means of attachment for the periodontal ligament to the tooth. When their bone is viewed radiographically, it is referred to as the lamina dura [13]. The lamina dura appears more dense than the adjacent supporting bone. Artificial tooth roots need some form of peri-artificial root-tissue to substitute for the periodontal tooth-supportive organ. Therefore, an artificial tooth root of the fibrous tissue attachment type was devised [2,3]. Artificial tooth roots were devised emphasizing conical, corrugated configurations common to human natural roots in order to stimulate the formation of bone [1,5]. Also minor physiological movement was applied to the artificial roots through moderately masticatory function to prevent ankylosis with alveolar bone immediately after implantation[16]. As a result, fibrous tissue resembling the lamina dura (the alveolar bone proper) and periodontal ligament which support natural teeth were developed around the artificial root. Conventional dental implants have been developed without such concepts. Conventonal implants are just planted into the jawbone as if they are anchors for a removal prosthesis. Mechanical supportive organs, i.e., the periodontal ligament and the alveolar bone proper, are indispensable for the mastication function of human teeth.

Ideally, it would be preferable to have anchorage of dental implants with the same functional mobility as natural teeth. The evidence of the lamina-dura-like appearance in accord with alveolar bone proper and a radiolucent space in accord with periodontal ligament seems possible to achieve an ideal bonding system of dental implants as in the present paper. Peri-implant structures need to have a similar to the periodontal ligament and the alveolar bone proper is needed for the long-term function of the artificial roots.

REFERENCES

1. Nishihara K, Akagawa T.: Comparative studies on periodontal tissues around new type artificial root made of zirconium oxide, titanium, and hydroxyapatite. Phosphorus Res Bul 1: 179~184, 1991.
2. Nishihara K. Kobayashi T, Akagawa T.: Light microscopic and SEM observation of tissue around new type artificial roots. Phosphorus Res Bul 1: 185~190,1991.
3. Nishihara K, Kobayashi T, Akagawa T.: Studies on periodontal tissues around a new type hydroxyapatite artificial root. Bioceramics 3:171~181,1992.
4. Nishihara K.: Studies on peri-root tissue formation around new type artificial root made of dense hydroxyapatite. Clin Materials 12: 159~167, 1993.
5. Nishihara K, Nakamura M, Nakagiri S.: Biomechanical studies on shape effect of hydroxyapatite artificial root upon surrounding jawbone. Clin Materials 16: 127~135, 1994.
6. Nishihara K, Nakagiri S.: Biomechanical studies on newly tailored artificial dental root. Bio-Medical Materials Engineering 4: 141~149, 1994.
7. Nishihara K.: What is the viscerocranium from the standpoint of vertebrate evolution. J Oromaxillofacial Biomechanics 1: 73~78,1995.
8. Albrektsson T, Berglundh T, Lindhe J.: Osseointegration: historic background and current concepts. Clinical Periodontology and Implant Dentistry. 4th Edition. Lindhe J. Karring T, Lang NP. Eds. Blackwell Pub. Co., Oxford, 2003, pp. 809~820.
9. Kirsch A.: The two-phase implantation method using IMZ intramobile cylinder implants. J Oral Implantol. 11:197~210, 1983.
10. Skalak R.: Biomechanical considerations in osseointegrated prostheses. J Prosthet Dent 49: 843~848, 1983.
11. Ten Cate AR.: Structure of the oral tissues. Oral Histology –Development, Structures, and Function. 5th edition. Mosby Co. St. Louis, 1998, pp.1~9.
12. Berkovitz, BKB, Holland GR, Moxham BJ. Functional anatomy. Oral Anatomy, Histology and Embryology 3rd edition. Mosby Co. London.2002, pp. 90~100.
13. Avery JK.: Histology of the periodotium: alveolar bone, cementujm, and periodontal ligament. Oral Development and Histology. Avery J. 3rd ed. Thieme. Stutgart.2002, pp. 225~243.
14. Buser D, Warren K, Karring T.: Formation of a periodontal ligament around titanium implants. J Periodontol. 61: 597~601, 1990.
15. Branemark PI, Adell R, Breine U, Hansson BO, Lindstrom J, Ohlsson A: Intraosseous anchorage of dental prostheses. I. Experimental studies. Scan J. Plastic Reconst Surg 3:81-100, 1969.
16. Nishihara K, Akagawa T.: Clinical applications of hydroxyapatite artificial root of fibrous tissue attachment type. Bioceramics 4:223~230, 1991.