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發 行 人 語

學會的學術期刊在大家的努力下終於要發行了，在此很感謝理監事會的支持及出版委員會的大力幫忙才得以完成這艱難的工作。在這各種植牙學會紛紛成立之時，發行學術期刊實為提升本會學術地位的良方，另因牙科教育訓練體系的改變及牙科各專科學會成為署定專科之趨勢，更使得發行期刊有其必要及時效性。在此感謝蕭裕源教授的鼎力幫忙及陳雅怡秘書長之協助，最後感謝各出版及編輯委員在繁忙的工作下能盡力幫忙，希望在我們共同努力下，期刊能如期發行並日益茁壯。

中華民國贗復牙科學會 理事長 沈裕福

April. 2012

Editorial

The Academy of Prosthetic Dentistry was established in 1996. This academy started out as a professional association for prosthodontists. However, there was no official publication platform for academic and research performance. In 2011, the President Dr. Shen, expressed his ambition for journal publication to the council of the academy. He was supported by the council, and the academy has decided to publish this journal. I was invited to organize a board of editors that is responsible for the acceptance and editing of papers submitted to the journal. This journal aims to publish research articles related to prosthodontics and implantology in both English and Chinese. Technical reports and clinical case reports are also welcome.

In this issue, an invited review article was written by an endodontist teaching in the University of Pennsylvania, USA. He paid much attention and studied on the relationship between dental health and mental health. His review will certainly invite attention and interest for prosthodontists who are providing good mastication platform for their patients, thus will help preventing senile dementia.

Four case reports have been presented. One case report is regarding denture construction for a combination syndrome patient, another three case reports are regarding implant insertion and superstructure construction. I believe these reports will invite appreciation and discussion from colleagues of prosthodontics and implantology. Unfortunately, there were no original research articles included in this issue mostly because of time constraints and research facility limitations for our members. We will improve this situation in future issues. On the other hand, two papers I called them “topical reviews” are included in this issue. They were written by graduate students under the supervision of their professors on topics they have planned to research further. Thorough review of literature and information is the first step toward a meaningful research methodology and material preparations. We encourage this kind of article and look forward to their continued and fruitful outcomes with full research papers in the future.

We are not completely satisfied with the contents of this issue, but “Rome wasn't built in a day”, with the active participation of our members and the efforts of our editorial board we will be able to achieve our goal. I believe this journal will meet the standards of popular journals in the immediate future, and becomes a platform for information sharing among prosthodontists and implantologists.

Yuh-Yuan Shiau

Editor–in-Chief

Review

Tooth Loss and Brain Damage: Multiple Recurrent Cortical Remapping Hypothesis

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Abstract

Basic biomedical knowledge of the neurobiological mechanisms of the deafferentation of stomatognathic systems has expanded greatly in recent decades. In both human and animal experimental trials, there are indications that the deafferentation of stomatognathic systems may be a critical factor in triggering and aggravating neurodegenerative diseases. This review explores basic neurobiological mechanisms associated with the deafferentation of stomatognathic systems; further included is a discussion on tooth loss and other oral-maxillofacial deafferentation (OMFD) mechanisms, with a focus on dental and periodontal apparatus that are associated with brain function and that may underlie the changes observed in the aging brain. A new hypothesis is proposed that tooth loss and changes in the functionality of teeth may cause brain damage due to recurrent remapping of the brain, and may even be a triggering and aggravating factor in the onset and progression of Alzheimer's disease. A growing understanding of the association of OMFD with brain aging may lead to solutions in treating and preventing cognitive decline and Alzheimer's disease.

Introduction

One of the greatest health threats of the twenty-first century has been cognitive frailty and cognitive decline of old age (Bishop et al., 2010). For adults over the age of 85, a predicted near-50% of this population segment will be afflicted with Alzheimer's disease. Recent advances in the biology of stomatognathic systems, together with human and animal experimental studies of the brain, are beginning to shed light on the neural mechanisms and their potential roles in cognitive decline. Clinicians may have to develop new concepts and strategies in coping with these new and challenging circumstances. Developing therapeutic interventions and preventive strategies for such conditions demands a greater understanding of the processes underlying normal and pathological brain aging related to stomatognathic systems.

The greatest risk factor for cognitive decline and Alzheimer's disease in older adults is age itself (Bishop et al., 2010). Cumulating scientific evidence have indicated a correlation between tooth loss and impaired brain functions such as memory loss, cognitive impairment, even prodromes of Alzheimer's disease and dementia (Avlund et al., 2004; Bergdahl et al., 2007; Gatz et al., 2006; Grabe et al., 2009; Kaye et al., 2010; Okamoto et al., 2010a, 2010b; Stein et al., 2007, 2010). Based on animal trials and clinical research, a recent review (Weijenberg et al., 2011) has highlighted the causal relationship of mastication on cognitive functions. The correlation between the loss of teeth with memory loss, cognitive impairment, and prodromes of Alzheimer's disease and dementia has not yet been fully explored. Kondo et al. (1994) hypothesized that tooth loss leads to a deprivation of sensory information input during mastication. Inflammatory mediators, bacteria, and toxins associated with periodontitis have been hypothesized to enhance brain inflammation (Grabe et al., 2009; Kamer et al., 2008, 2012; Kim et al., 2007), though as yet no conclusive study has been completed. In combining the latest studies, a new hypothesis is proposed: Loss of teeth and changes in the functionality of teeth may cause serious damage to the function of the brain, and may even be a triggering and aggravating factor in the onset and progression of Alzheimer's disease and dementia.

Tooth and Memories Associated with the Function of Mastication

During the period of mixed dentition, the roots of the primary teeth begin absorption while permanent teeth begin growth and eruption. Post-eruption, the permanent teeth eventually complete occlusion and allow mastication. The sensory receptors inside the periodontal ligament of the permanent teeth adapt to various functions, including mastication (Trulsson, 2006, 2007; van der Glas et al., 2007). This growth continues as the function of occlusion-mastication matures and stabilizes. During the stabilization period, the periodontal sensory receptors of the teeth—including mechanoreceptors, proprioceptive receptors, nociceptive receptors, and other related receptors and nerve endings—build a functional neuronal connection with the sensory cortex, on both conscious and unconscious levels (Trulsson, 2006, 2007; van der Glas et al., 2007). The periodontal sensory receptors of the teeth coordinate with masticatory muscles and joints to form a very precise neuromuscular reflex (van der Glas et al., 2007). After accumulating years of functional memories, the matured and integrated occlusion-mastication function becomes a basic and even pleasurable physical act.

In the mature and integrated occlusion-mastication act, processing food is not the only mechanical function. Before eating an apple, for example, memories relating to this occlusion-mastication act remind us that when we bite into the apple, we may expect a crisp and juicy, fragrant and sweet sensory event. This feedforward memory and recognition result from the coordinated and synchronized crossmodal, multisensory recognition among visual sensory receptors, olfactory sensory receptors, gustatory sensory receptors (Boucher et al., 2006), periodontal mechanoreceptors (Trulsson, 2006, 2007) and even the central connection and organization of multiple sensory inputs by the cortical neurons (Hirano et al., 2008; Momose et al., 1997; Sesay et al., 2000; Takada et al., 2004, Trulsson et al., 2010). After we have bitten into and began chewing on the apple, all related sensory receptors began its recognize, evaluate, and enjoy the fruit. This simple process of ingesting food is a complex harmonization of conscious and unconscious recognition, memory, conditioned reflexes, and many other functions as multiple neural transmissions, evaluations, decisions, and executions happen simultaneously. In the comprehensive execution of this neural process, the teeth play a prominent role, as its nerve endings and sensory receptors enable the necessary precision in the massive and comprehensive coordination of diverse players in the occlusion-mastication act (Trulsson, 2006, 2007). In this occlusion-mastication "symphony orchestra," each tooth is a "musician" performing its indelible, intricate, and indispensable function in creating the overall harmony of occlusion-mastication. Should one or more "musician" (teeth) were to change their function or become missing, the orchestra's overall harmony is doubtlessly affected, creating temporary or long-term dissonances and increasing mental and physical stress. To adapt to alterations, cope with stress, and maintain the effectiveness of the occlusion-mastication function in the face of such changes, it is necessary for related sensory cortical and motor remapping (Avivi-Arber et al., 2010; Henry et al., 2005).

Tooth and Head/Neck Activities Associated with the Function of Mastication

As discussed previously, processing food is not the only aim of the occlusion-mastication act. Before, during, and after food ingestion, all twelve pairs of cranial nerves related to the head/neck sensory and motor functions simultaneously coordinate and integrate all relevant information. Additionally, all masticatory muscles, as well as all the muscles of the head and the neck, participate directly and indirectly during the occlusion-mastication act. The exercise of these aforementioned muscles is necessary for survival; it is also a natural pattern of routine for the head and the neck. A growing body of literature suggests that physical activity beneficially influences brain function and executive cognitive processes (Ratey and Loehr, 2011). Evidence also indicates that mastication can affect regional cerebral blood flow (Hirano et al., 2008; Momose et al., 1997; Sesay et al., 2000; Takada et al., 2004).

The occlusion-mastication act can be changed locally and comprehensively by pain due to decay, periodontal disease, or removal of permanent teeth necessary in the occlusion-mastication act; this change may lead to subsequent changes in the motor patterns of the head and neck. In cases of multiple teeth loss, the motor function of the head and neck (in particular the quality and quantity of the masticatory muscular exercises) are also affected. Long-term negative effects of such a scenario have been shown in animal and clinical studies (Andoh et al., 2009; Kato et al., 1997; Kawanishi et al., 2010; Kaye et al., 2010; Makiura et al., 2000; Miura et al., 2003; Ono et al., 2010, Onozuka et al., 1999, 2000; Tsutsui et al., 2007; Watanabe et al., 2002; Yamazaki et al., 2008) and may be plausibly linked to an impaired learning abilities, loss of memory, and subsequent development into prodromes of Alzheimer's disease and dementia.

Tooth Loss and Hypothesized Multiple Recurrent Sensory and Motor Cortical Remapping

Tooth loss leads to change in the occlusion-mastication function, which in turn leads to sensory cortical and motor cortical remapping (Avivi-Arber et al., 2010; Henry, et al., 2005). The sensory cortex of permanent teeth holds the functional and mature memories of the occlusion-mastication-ingestion act. Once affected by the sensation of pain due to cavities or periodontal diseases, changes may take place, locally and centrally, in the occlusion-mastication act, causing transitional sensory cortical remapping (Iyengar et al., 2007). In other words, the loss of the functional and mature memories (due to the damage or removal of permanent teeth) may cause sustained, even permanent, sensory cortical and motor cortical remapping (Avivi-Arber et al., 2010; Henry et al., 2005). From the nerve endings and sensory receptors in the damaged permanent teeth, to the neurons in the central nervous system, all related functional connections undergo a cortical reorganization during the sensory cortical and motor cortical remapping. Simultaneously occurring are local cortical re-circuitry, regional cortical rewiring, even large-scale cortical restructuring (Iyengar et al., 2007). The process of the primary sensory cortical remapping may overlap into areas of proximate cortical units, which may in turn affect the cortical circuitries of teeth, gingiva, and oral mucous membrane proximate to the affected adjacent tooth or teeth (Henry et al., 2005). It is hypothesized that when neighboring or opposing teeth are lost subsequently, a secondary sensory cortical remapping is likely to occur, with an ever-expanding area being affected by the process of the cortical remapping. Ex analogia, multiple, sequential loss of adjacent teeth may cause tertiary and quaternary sensory cortical remapping. With each remapping, the affected cortical area grows larger, and with continuous cortical rewiring and rebuilding and little time for maturation, the new neuronal pathways become always further removed from the semblance of the original optimal connections, decreasing the efficacy of the sensory cortical and motor neuronal pathways for the occlusion-mastication related function and its associated memories and cognition.

In the primary motor cortical remapping process, the area affected by the remapping may expand to nearby cortical neurons, such as cortical neurons controlling the anterior belly of digastric muscle and geniglossus muscle (Avivi-Arber et al., 2010). It is hypothesized that if neighboring or adjacent teeth are lost subsequently, a secondary motor cortical remapping is likely to occur, with an ever-expanding area being affected by the process of the cortical remapping. With each remapping, the affected cortical area grows larger, and with continuous cortical rewiring and rebuilding and little time for maturation, the new neuronal pathways become yet further removed from the semblance of the original optimal connections, decreasing the efficacy of the sensory cortical and motor neuronal pathways for the occlusion-mastication function and its related memories and cognition.

Recent research studies have shown that a breakdown in the composition and organization appears clearly and definitively in anatomical regions of brain affected by Alzheimer's disease, thus forming the disconnection syndrome (He et al., 2009). The etiology of the disconnection syndrome correlates to the disruption of the neuronal integrity of large-scale brain networks. The memory, motor, and cognitive functions relating to the occlusion-mastication act covers multiple anatomical sub-areas of the brain, including the primary and secon dary motor and sensory cortices, the temporal, parietal, and occipital lobes, and more (Hirano et al., 2008; Momose et al., 1997; Sesay et al., 2000; Takada et al., 2004, Trulsson et al., 2010). It is hypothesized that multiple teeth loss and subsequent changes in the occlusion-mastication function cause ever-expanding motor and sensory cortical remapping. Furthermore, the less efficient cortical rewiring and rebuilding of the large-scale brain networks, combined with aging (when breakdowns in cerebral composition and organization are more likely), may lead to a loss of plasticity and an increase in disconnection in the brain. As the disconnection syndrome progresses, it is likely that this sequence of events, which began with the loss of multiple teeth, is likely cause and worsening factor for Alzheimer's disease and dementia (Bergdahl et al., 2007; Gatz et al., 2006; Grabe et al., 2009; Kaye et al., 2010; Okamoto et al., 2010a, 2010b; Ono et al., 2010; Stein et al., 2007, 2010).

The Scope of Sensory cortical and Motor Remapping

When a tooth is lost, its periodontal and pulp sensory receptors (including mechanoreceptors, proprioceptive receptors, nociceptive receptors, and other related receptors and nerve endings) are also lost. The accompanying functions of these missing receptors and nerve endings are reassigned to adjacent teeth and tissues during the cortical remapping process (Henry et al., 2005). However, in the primary sensory cortical remapping process, the affected areas are not limited to the sensory receptors of the lost teeth, nor limited to its related areas: The sensory functions of adjacent oral mucosa, tongue, and taste buds are also affected and changed (Habre-Hallage et al., 2011, Boucher et al., 2006). Subsequently, functional changes may occur to the corresponding sensory cortex and the relay neurons of the central nervous system of these affected oral and lingual mucosa and tissues. Starting within the sensory and motor cortices, a massive cortical modification, reorganization, and reintegration begins in order to adapt all related nerve endings and receptor cells, even various relay neurons in the central nervous system (Jain et al., 2008). (A simultaneous rebuilding of the cortical nervous pathways may occur, including local, regional, and large-scale cortical rewiring and re-integration.)

Tooth Loss Leads to Difficult Retrieval, or Complete Loss of, Associated Memory

When a tooth is lost, its interior sensory receptors (including mechanoreceptors, proprioceptive receptors, nociceptive receptors, and other related receptors and nerve endings) are also lost. The accompanying functions of these missing receptors and nerve endings are reassigned to adjacent teeth and tissues during the cortical and sensory cortical remapping process. However, the dental sensory functions make up an important part in the precise neuromuscular reflex and all related and associated memories. A change or damage in the dental sensory function may cause a comprehensive change in the mastication and related function such as postural balance control (Cuccurazzu et al., 2007, Kushiro and Goto, 2011; Yoshida et al., 2009). It is hypothesized that after a certain amount of patching and adapting, the mastication function may partially return, but the precise dental sensory function, as well as the cumulated functional (reflex) memory and its related conscious and unconscious cognitive chewing-related memories, may be difficult to retrieve, gradually fading away or even no longer in existence. Additionally, the sensory functions of the adjacent oral membrane, tongue membrane, and taste buds are also affected and changed by tooth loss (Boucher et al., 2006). All related functional memory and conscious and unconscious cognitive memory are subsequently affected and changed, very possibly damaged, difficult to retrieve, or even permanently lost.

Possible Damage to Brain Functions Caused by Tooth Loss

A growing number of research evidence show that the loss of peripheral sensory functions, along with age difference and puberty, correlates with the neuroplastic changes of the brain, and may even form crossmodal neuroplastic changes (Merabet and Pascual-Leone, 2010). The loss of peripheral sensory receptors and OMFD may also lead to behavioral adaptations causing multiple levels of impact and change in the brain (Cuccurazzu et al., 2007, Deriu et al., 2010; Jain et al., 2008; Kushiro and Goto, 2011; Yoshida et al., 2009).

When multiple teeth loss occurs, the subsequent sensory and motor cortical remapping, rewiring, and rebuilding of various neural pathways on multiple levels make it difficult in the extreme to return to the original optimal connections and precise neuromuscular and associated crossmodal multisensory functions. Furthermore, continuous cortical rewiring and rebuilding of neural pathways may result in serious non-ideal or over-detoured connections, thus losing the functions' original high efficacy level. It is hypothesized that long-term, regular use of these non-ideal connections is likely to cumulate in abnormal levels of burden, may result in producing excessive Beta - Amyloid, causing synaptic and extra-synaptic dysfunction (Bordji et al., 2010, 2011; Gladding and Raymond, 2011) and taxing the limits of the brain's neuroplasticity. In certain circumstances, all of these conditions may combine to form short circuits, becoming the proverbial final straw in breaking the last surviving normal brain functions.

Permanent teeth are equipped with mastication functions and mature memories and losing them causes functional changes in the brain. It is possible to adapt to these changes; however, as the brain ages, the plasticity of the brain decreases as well, and, it is hypothesized that should the brain's functions be further shocked by the loss of strategic molars, the brain may suffer varying degrees of impact on multiple levels. In the aging process, multiple losses of teeth and its consequent effects may lead to various levels of cognitive and memory loss in old age, even dementia or Alzheimer's disease (Avlund et al., 2004; Bergdahl et al., 2007; Gatz et al., 2006; Grabe et al., 2009; Kaye et al., 2010; Okamoto et al., 2010a, 2010b; Ono et al., 2010; Stein et al., 2007, 2010).

As shown by the above hypotheses and worthwhile leads, new light may be shed on the research on the etiology and treatment of Alzheimer's disease and new directions and strategies considered for future studies in the fascinating link between teeth loss and brain change.

References

1. Andoh T, Sakuma Y, Yamamoto S, Matsuno A, Maeda T, Kotani J. Influences of molar loss of rat on learning and memory. Journal of Prosthodontic Research 2009; 53: 155-60.
2. Avivi-Arber L, Lee J C, Sessle BJ. Effects of incisor extraction on jaw and tongue motor representations within face sensorimotor cortex of adult rats. The Journal of Comparative Neurology 2010; 518: 1030-45.
3. Avivi-Arber L, Lee JC, & Sessle BJ. Face sensorimotor cortex neuroplasticity associated with intraoral alterations. Progress in Brain Research Chapter 9 2011;188: 135-50.
4. Avlund K, Holm-Pedersen P, Morse DE, Viitanen M, Winblad B. Tooth loss and caries prevalence in very old swedish people: The relationship to cognitive function and functional ability. Gerodontology 2004; 21: 17-26.
5. Bishop NA, Lu T, Yankner BA. Neural mechanisms of ageing and cognitive decline. Nature 2010; 464: 529-35.
6. BoucherY, Berteretche MV, Farhang F, Arvy MP, Azerad J, Faurion A. Taste deficits related to dental deafferentation: An electrogustometric study in humans. European Journal of Oral Sciences, 2006; 114: 456-64.
7. Breivik T, Thrane PS, Gjermo P, Cools A, Myhrer T. Effects of hippocampal lesioning on experimental periodontitis in wistar rats. Journal of Periodontal Research, 2002; 37: 360-5.
8. Gatz M, Mortimer JA, Fratiglioni L, Johansson B, Berg S, Reynolds CA, et al. Potentially modifiable risk factors for dementia in identical twins. Alzheimer's & Dementia : The Journal of the Alzheimer's Association 2006; 2: 110-7.
9. Grabe HJ, Schwahn C, Volzke H, Spitzer C, Freyberger HJ, John U, et al. Tooth loss and cognitive impairment. Journal of Clinical Periodontology 2009;36: 550-7.
10. He Y, Chen Z, Gong G, Evans A. Neuronal networks in Alzheimer's disease. The Neuroscientist : A Review Journal Bringing Neurobiology, Neurology and Psychiatry 2009; 15: 333-50.
11. Henry EC, Marasco PD, Catania KC. Plasticity of the cortical dentition representation after tooth extraction in naked mole-rats. The Journal of Comparative Neurology 2005; 485: 64-74.
12. Iyengar S, Qi HX, Jain N, Kaas JH. Cortical and thalamic connections of the representations of the teeth and tongue in somatosensory cortex of new world monkeys. The Journal of Comparative Neurology 2007; 501: 95-120.
13. Kato T, Usami T, Noda Y, Hasegawa M, Ueda M, Nabeshima T. The effect of the loss of molar teeth on spatial memory and acetylcholine release from the parietal cortex in aged rats. Behavioural Brain Researc 1997; 83: 239-42.
14. Kawanishi, K., Koshino, H., Toyoshita, Y., Tanaka, M., & Hirai, T. Effect of mastication on functional recoveries after permanent middle cerebral artery occlusion in rats. Journal of Stroke and Cerebrovascular Diseases : The Official Journal of National Stroke Association 2010;19: 398-403.
15. Kaye EK, Valencia A, Baba N, Spiro A III, Dietrich T, Garcia RI. Tooth loss and periodontal disease predict poor cognitive function in older men. Journal of the American Geriatrics Society 2010;58: 713-8.
16. Makiura T, Ikeda Y, Hirai T, Terasawa H, Hamaue N, Minami M. Influence of diet and occlusal support on learning memory in rats behavioral and biochemical studies. Research Communications in Molecular Pathology and Pharmacology 2000;107: 269-77.
17. Merabet LB, Pascual-Leone A. Neural reorganization following sensory loss: The opportunity of change. Nature Reviews. Neuroscience 2010; 11: 44-52.
18. Miura H, Yamasaki K, Kariyasu M, Miura K, Sumi Y. Relationship between cognitive function and mastication in elderly females. Journal of Oral Rehabilitation 2003; 30: 808-11.
19. Momose T, Nishikawa J, Watanabe T, Sasaki Y, Senda M, Kubota

K, et al. Effect of mastication on regional cerebral blood flow in humans examined by positron-emission tomography with (1) O-labelled water and magnetic resonance imaging. Archives of Oral Biology 1997; 42: 57-61.

20. Okamoto N, Morikawa M, Okamoto K, Habu N, Hazaki K, Harano A, et al. Tooth loss is associated with mild memory impairment in the elderly: The fujiwara-kyo study. Brain Research 2010a; 1349: 68-75.

21. Okamoto N, Morikawa M, Okamoto K, Habu N, Iwamoto J, Tomioka K, et al. Relationship of tooth loss to mild memory impairment and cognitive impairment: Findings from the fujiwara-kyo study. Behavioral and Brain Functions 2010b; 6: 77.

22. Ono, Y., Yamamoto, T., Kubo, K. Y., & Onozuka, M. Occlusion and brain function: Mastication as a prevention of cognitive dysfunction. Journal of Oral Rehabilitation 2010;37: 624-40.

23. Onozuka M, Watanabe K, Mirbod SM, Ozono S, Nishiyama K, Karasawa N, et al. Reduced mastication stimulates impairment of spatial memory and degeneration of hippocampal neurons in aged SAMP8 mice. Brain Research 1999; 826: 148-53.

24. Onozuka, M., Watanabe, K., Nagasaki, S., Jiang, Y., Ozono, S., Nishiyama, K., et al. Impairment of spatial memory and changes in astroglial responsiveness following loss of molar teeth in aged SAMP8 mice. Behavioural Brain Research 2000; 108: 145-55.

25. Sesay, M., Tanaka, A., Ueno, Y., Lecaroz, P., & De Beaufort, D. G. Assessment of regional cerebral blood flow by xenon-enhanced computed tomography during mastication in humans. The Keio Journal of Medicine 2000;49 Suppl 1: A125-8.

26. Stein, P. S., Kryscio, R. J., Desrosiers, M., Donegan, S. J., & Gibbs, M. B. Tooth loss, apolipoprotein E, and decline in delayed word recall. Journal of Dental Research 2010;89: 473-7.

27. Ratey, J. J., & Loehr, J. E. The positive impact of physical activity on cognition during adulthood: A review of underlying mechanisms, evidence and recommendations. Reviews in the Neurosciences 2011; 22: 171-85.

28. Stewart, R., Sabbah, W., Tsakos, G., D'Aiuto, F., & Watt, R. G. Oral health and cognitive function in the third national health and nutrition examination survey (NHANES III). Psychosomatic Medicine 2008;70: 936-41.

29. Tsutsui, K., Kaku, M., Motokawa, M., Tohma, Y., Kawata, T., Fujita, T., et al. Influences of reduced masticatory sensory input from soft-diet feeding upon spatial memory/learning ability in mice. Biomedical Research 2007; 28: 1-7.

30. Watanabe, K., Ozono, S., Nishiyama, K., Saito, S., Tonosaki, K., Fujita, M., et al. The molarless condition in aged SAMP8 mice attenuates hippocampal fos induction linked to water maze performance. Behavioural Brain Research 2002;128: 19-25.

31. Weijenberg, R. A., Scherder, E. J., & Lobbezoo, F. Mastication for the mind--the relationship between mastication and cognition in ageing and dementia. Neuroscience and Biobehavioral Reviews 2011;35: 483-97.

32. Yamazaki, K., Wakabayashi, N., Kobayashi, T., & Suzuki, T. Effect of tooth loss on spatial memory and trkB-mRNA levels in rats. Hippocampus 2008;18: 542-7.

Case Report

Vertical Ridge Augmentation with a Titanium-Reinforced ePTFE Membrane And Tenting Screws: A Case Report

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Abstract
The present report demonstrates a clinical procedure to restore an edentulous area with severe bone destruction using ridge augmentation and implant placement. Titanium-reinforced, expanded polytetrafluoroethylene (ePTFE) membrane and tenting screws combined with a mixture of autograft and allograft (rate 50%: 50%) were used for guided bone regeneration (GBR). A two-stage surgery was performed to remove the non-resorbable membrane after 6 months healing period and delayed implants were placed. A vertical bone height of 8.0 mm (from 7.5 mm to 15.5 mm) and 7.0 mm (from 8.5 mm to 15.5 mm) was gained in the edentulous area corresponding to tooth #36 and #37, respectively compared to the radiographic image of the atrophic ridge before GBR. Final superstructures on #36 and #37 were obtained with favorable crown-root ratio. One and half year follow-up examination showed stable marginal bone level and healthy peri-implant mucosa.

Key words: vertical ridge augmentation, GBR, Ti-reinforced ePTFE membrane, dental implant, tenting screws

Introduction

Subsequent horizontal and vertical bone loss is unavoidable and often difficult to restore when teeth are lost due to advanced periodontitis. Vertical bone defect is more complicated to handle because of its high technical sensitivity. Schmid et al. [1] presented in 1991 vertical bone regeneration around the protruded implants covered with an expanded polytetrafluoroethylene (ePTFE) membrane in rabbit skulls. Similar results reported Linde et al [2], Jovanovic et al [3] and Renvert et al [4]. Simion et al [5] reported the first human and histologic study of vertical ridge augmentation using a titanium-reinforced membrane and osseointegrated implants. Guided bone regeneration (GBR) technique has been developed to restore the lost hard tissue from the broken walls where periodontal destruction happens [6, 7]. The composite graft consisting of autogenous bone and freeze-dried bone allograft (FDBA) has osteogenic properties. It maintains space for the created bone volume to improve the treatment outcome and predictability [8]. Regenerated bone provides good implant stability according to long-term follow-up studies [9 - 11]. The present report applied such a technique and obtained a satisfactory result for an edentulous area with severe bone loss.

Patient condition and treatment planning

A medically stable 48-year-old, non-smoking woman suffered from advanced periodontitis of the teeth #36, #37 and #47. The periapical radiographic examination of the lower left mandibular posterior region revealed severe alveolar bone loss around #36 and #37 (Figure 1). The prognosis was hopeless and #36, #37 should be extracted. The reconstruction plan was to restore left side dentition first followed by a right site reconstruction.

Extraction and pre-implant GBR

Teeth #36 and #37 were extracted and soft tissue healing was completed about 8 weeks later. Panoramic X-ray showed severe bone destruction at lower left posterior edentulous ridge (Figure 2). The GBR procedure was performed under local anesthesia with 2% lidocaine and 1:100,000 epinephrine (Figure 3a). A full-thickness midcrestal incision was made on the edentulous area using a sulcular extension to the disto-buccal aspect of tooth #37 (Figure 3b). The flaps were elevated to expose the atrophic ridge and the immature healing sockets (Figure 3c). Evident vertical and horizontal bone defects were found.

Decortication of the ridge was performed using a round bur to expose the medullary spaces and promote the bleeding process. Two tenting screws (7mm and 9mm in length) were positioned at the existed bone peak level of the adjacent tooth (#35) and distal ramus area (Figure 3d). Autogenous bone (Figure 3e) was harvested by disposable Safe-scraperR in situ at the distolateral aspect of the mandibular ramus and mixed with freeze-dried bone allograft (FDBA) particles (Figure 3f), (rate 50%: 50%). The Ti-reinforced ePTFE membrane (TR6Y) was shaped for perfect adaptation and fixed to the lingual and buccal plates with 3 tacks (Screw tack, ACER), (Figure 3g). The membrane was placed 2 mm away from the #35 root surface to keep off bacterial contamination from the sulcus. Safety distance was maintained to the mental nerve while inserting the tacks to fix the membrane and performing periosteal releasing incisions. Tension-free flap was achieved using sufficient periosteal releasing incisions for primary wound closure. The soft tissue was secured with non-resorbable horizontal mattress sutures and interrupted sutures (Figure 3h and 3i). Postoperative panoramic radiograph showed overlying membrane, 2 tenting screws and 3 fixation screws (Figure 3j).

The patient was prescribed with antibiotic and analgesic medication (Doxymycin 100 mg/cap, twice a day for 7 days; Ponstan 250 mg/cap, three times a day for 5 days) to prevent postoperative infection and pain. The patient was advised to use mouth rinse with 0.2% chlorhexidine gluconate for postoperative wound care. The sutures were removed after 14 days. Healing was uneventful. There was no soft tissue dehiscence or membrane exposure.

Fig. 1
Periapical radiograph revealed severe bone destruction around tooth #36 and #37.

Fig. 2
Panoramic radiograph showed large vertical defects at the lower left edentulous ridge.

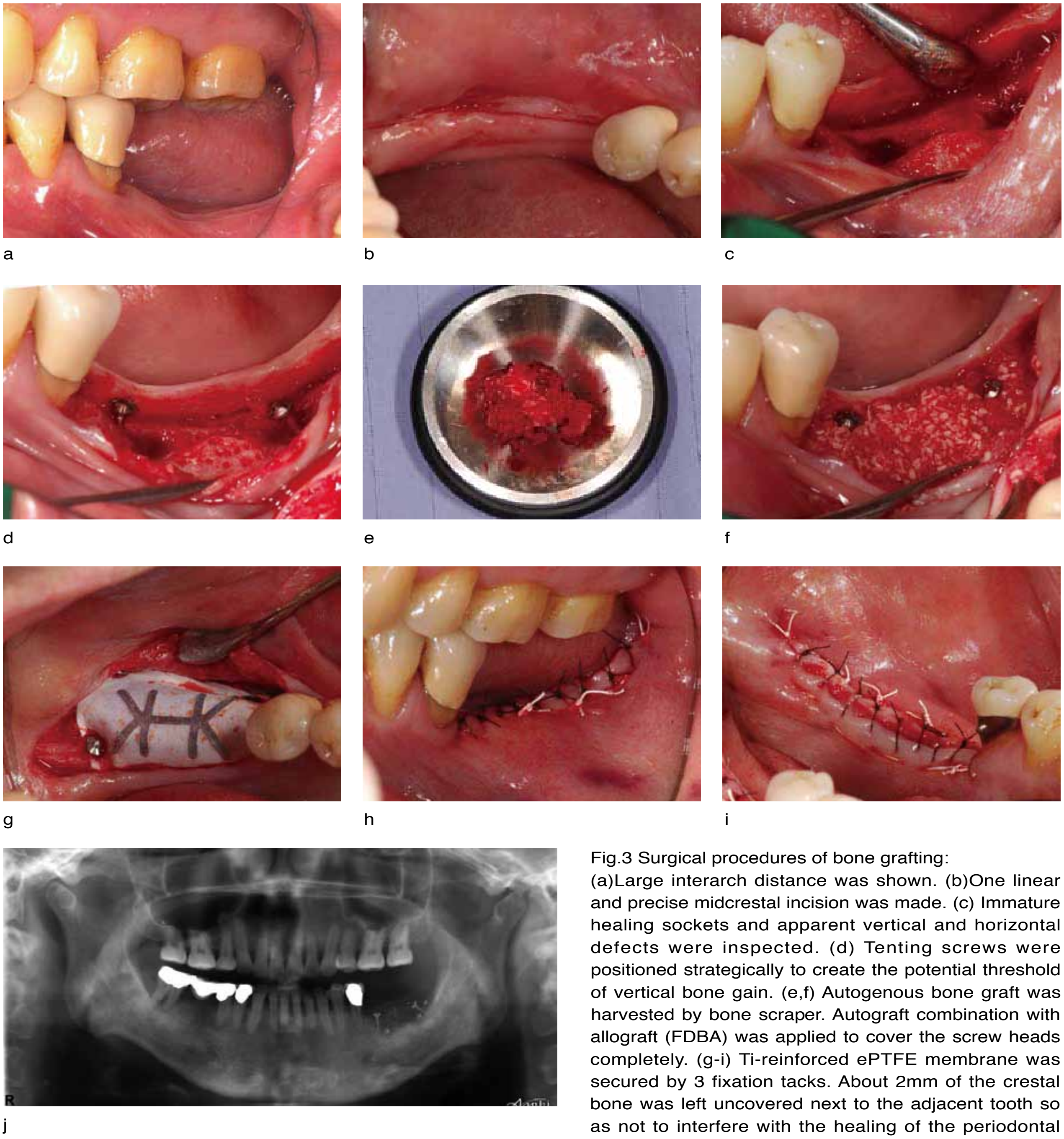
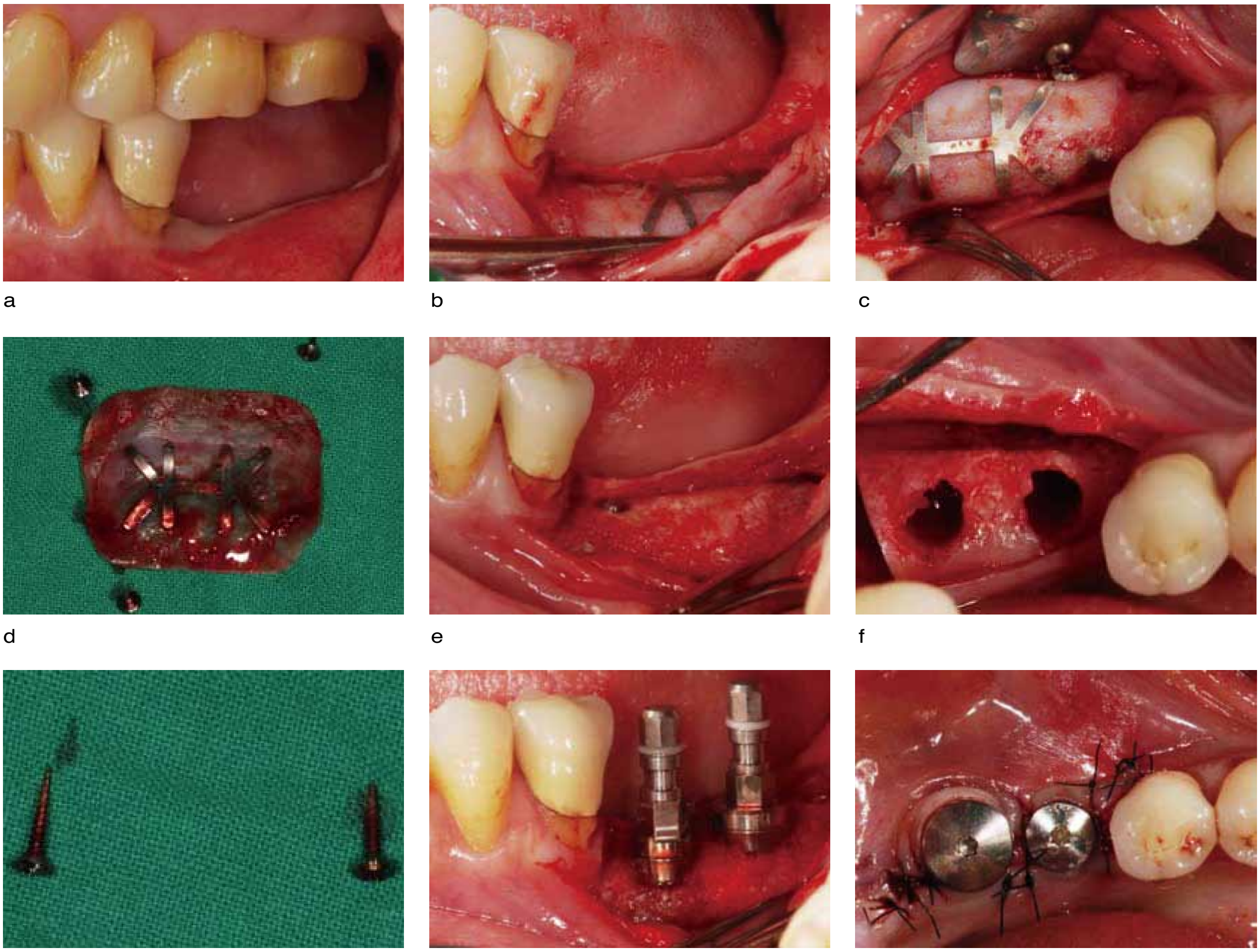


Fig.3 Surgical procedures of bone grafting:
(a)Large interarch distance was shown. (b)One linear and precise midcrestal incision was made. (c) Immature healing sockets and apparent vertical and horizontal defects were inspected. (d) Tenting screws were positioned strategically to create the potential threshold of vertical bone gain. (e,f) Autogenous bone graft was harvested by bone scraper. Autograft combination with allograft (FDBA) was applied to cover the screw heads completely. (g-i) Ti-reinforced ePTFE membrane was secured by 3 fixation tacks. About 2mm of the crestal bone was left uncovered next to the adjacent tooth so as not to interfere with the healing of the periodontal tissues. Primary wound closure was achieved with nonresorbalbe horizontal and interrupted sutures. (j) The postoperative panoramic radiograph displayed the overlying membrane, 2 tenting screws and 3 fixation tacks



a b c d e f g h i

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Fig.4
(a-c) After 6 months of healing, re-entry revealed the Ti-reinforced membrane appeared stable with the fixation screws in place. (d-g) Substantial regenerated bone fill of the defect was noted after carefully removing of the membrane and screws. (h,i) Two dental implants were inserted and connected to their healing abutments. (j) The radiograph shows that the implants were surrounded by the augmented bone.

Implant placement

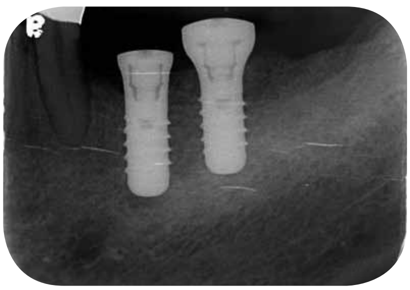
The 2nd stage of the surgery was performed after 6 months to remove the non-resorbable membrane (Figure 4a, 4b, 4c and 4d). A re-entry on the site revealed regenerated hard tissue covering the tenting screws surface (Figure 4e). Two titanium dental implants (Straumann R £ X 4.8 mm X 10 mm, RN, SP; £ X 4.8 mm X 10 mm, WN, SP) were inserted after removal of the tenting screws (Figure 4g). The implant of regular neck type was chosen according to the compromised width of the augmented crest bone at the first molar area (Figure 4f). The implant position of the first molar shifted distally and the shoulder level was in a deeper corono-apical direction for complete bone coverage of the implant surface (Figure 4h). Soft tissue was closed with 5-0 Nylon interrupted sutures (Figure 4i).

Radiography revealed that the two implants were positioned properly and that the surrounding bone tissue was sound three and half months later (Figure 5a). 2 solid abutments (7 mm for RN, 5.5 mm for WN) were placed with 35 N/cm insertion torque value (Figure 5b, 5c).

Two separate crowns were made without splinting because the two implants had different levels of shoulders in the corono-apical dimension (Figure 5d, 5e). The final prostheses had favorable crown-root ratio in the periapical radiograph (Figure 5f).

Follow-up

One and half year follow-up examination showed stable marginal bone level (Figure 6a) and healthy peri-implant mucosa (Figure 6b and 6c).



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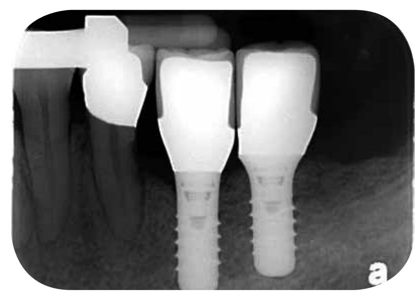

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Fig.5 Dental prosthesis after implant placement:
(a) The boundary between augmented and native bone is ambiguous. (b,c) Two solid abutments were placed. (d,e) Two implant supported restorations without splinting were placed with satisfactory clinical appearance. (f) Periapical radiograph shows the implants and the prosthesis with favorable crown-root ratio.

a

b

c

Fig.6
(a) Final restorations after 8-month follow-up showed satisfactory marginal bone level. (b,c) Peri-implant mucosa with pink and healthy appearance.

Discussion

Vertical ridge augmentation can be achieved by other techniques such as alveolar distraction osteogenesis (ADO), [12-14] and inlay/onlay grafting [15, 16]. ADO can produce consistent bone regeneration [17], and autograft is commonly thought to be the gold standard of graft selection [18]. GBR, however, has better control over the undesired axis of regenerated bone compared to ADO [14] and little space limitation as a distractor application at the mandibular area [19]. GBR can minimize the usage of precious and rare autogenous bone block from the oral cavity [20, 21].

An insufficiency of vertical bone height for implant placement or a large distance often requires changes of coronal length and form resulting in an unfavorable crown-root ratio of dental prosthesis. This is the main indication for vertical ridge augmentation. Nissan et al [22] reported recently that the crown height space of unsplinted implant supports prosthesis over 15 mm high but that it has a higher rate of implant failure. In the present case, successful vertical ridge augmentation via GBR instead of implantation on the native bone height reduced the consequent crown height space to less than 15 mm. Establishment of the adequate vertical crown space was believed to have better long-term prognosis and stability.

Urban et al [23] demonstrated that the mean vertical augmentation was 5.5 to 2.29 mm. The existing periodontium of the adjacent teeth should be the main consideration in predicting the volume of the bone that can be regenerated. Bone peaks of adjacent teeth show the effect of space making and maintenance, which is the key for bone regeneration [24]. Support can be obtained using tenting screws that can enhance the effect of propping up the overlying barrier and enhance space maintenance for the severe atrophic edentulous ridge. Hence, two tenting screws were used in this case. A vertical bone height of 8 mm and 7 mm in the edentulous ridge was gained corresponding to the tooth #36 and #37, respectively. Le et al [25] reported even thicker vertical augmentation of 9.7 mm mean value. Using tenting screws in large vertical defects can be regarded as a better protocol for ridge augmentation according to Le et al and our experience.

Premature membrane exposure resulting in postoperative infection is the major and most frequent complication even though ePTFE membrane is advantageous in GBR [26, 27]. Therefore, correct membrane placement and stabilization with fixation screws and primary passive closure are mandatory. To avoid bacterial contamination from the adjacent tooth and potential damage to the mental nerve, the membrane was placed more distally to the adjacent root surface and mental foramen in this case. Thus, compromised horizontal volume of crest morphology at the first molar was unavoidable. High technical sensitivity of the ePTFE membrane is important compared to the bioresorbable barrier membrane, which is easier to handle during surgery [28]. Hence, ePTFE membrane application has a limited popularity.

Conclusion

GBR with Ti-reinforced ePTFE membrane, tenting screws and bone grafts offers predictable functional reconstruction of large vertical defects. Long-term success and survival rates can be predicted. This technique is also a feasible and successful way to create a desirable crown/root ratio for implant prosthesis.

摘要

本報告說明如何利用階段性骨脊增進術(staged approach of ridge augmentation)以及人工植體置入，重建一個有嚴重骨破壞的左下第一及第二大臼齒缺牙區。本案例於引導骨再生(guided bone regeneration)手術中，使用不可吸收性再生膜（Ti-reinforced ePTFE membrane）及支撐釘（tenting screws）以支撐混合的自體骨(autograft)與異質移植骨(allograft)填充物。經過六個月的癒合期後，第二次手術時將不可吸收性的再生膜移除，並同時置入人工植體。術後X光片顯示的齒槽骨高度，與未施行引導骨再生術前的萎縮齒槽骨脊做比較，可見在左下第一大臼齒的齒位區，骨脊高度從7.5mm增加至15.5mm，共增加了8.0mm，以及在左下第二大臼齒的齒位區，骨脊高度從8.5mm增加至15.5mm，共增加了7.0mm的垂直高度；而後以固定式義齒重建，也獲得理想的冠-根比，經過一年半的追蹤，目前植體周圍的齒槽骨依然保持穩定的高度。

關鍵詞：垂直骨脊增進術、引導骨再生術、不可吸收性再生膜、人工植體、骨釘

References

1. Schmid J, Hämmerle CH, Stich H, Lang NP. Supraplant, a novel implant system based on the principle of guided bone generation. A preliminary study in the rabbit. Clin Oral Implants Res 1991;2:199-202.
2. Linde A, Thorén C, Dahlin C, Sandberg E. Creation of new bone by an osteopromotive membrane technique: an experimental study in rats. J Oral Maxillofac Surg 1993;51:892-7.
3. Jovanovic SA, Schenk RK, Orsini M, Kenney EB. Supracrestal bone formation around dental implants: An experimental dog study. Int J Oral Maxillofac Implants 1995;10:23-31.
4. Renvert S, Claffey N, Orafi H, Albrektsson T. Supracrestal bone growth around partially inserted titanium implants in dogs. A pilot study. Clin Oral Implants Res 1996;7:360-5.
5. Simion M, Trisi P, Piattelli A. Vertical ridge augmentation using a membrane technique associated with osseointegrated implants. Int J Periodontics Restorative Dent 1994;14:496-511.
6. Rocchietta I, Fontana F, Simion M. Clinical outcomes of vertical bone augmentation to enable dental implant placement: a systematic review. J Clin Periodontol 2008;35:203-15.
7. Langer B, Langer L, Sullivan RM. Vertical ridge augmentation procedure using guided bone regeneration, demineralized freeze-dried bone allograft, and miniscrews: 4- to 13-year observations on loaded implants. Int J Periodontics Restorative Dent 2010;30:227-35.
8. Buser D, Hoffmann B, Bernard JP, Lussi A, Mettler D, Schenk RK. Evaluation of filling materials in membrane-protected bone defects. A comparative histomorphometric study in the mandible of miniature pigs. Clin Oral Implants Res 1998;9:137-50.
9. Dahlin C, Lekholm U, Linde A. Membrane-induced bone augmentation at titanium implants. A report on ten fixtures followed from 1 to 3 years after loading. Int J Periodontics Restorative Dent 1991;11:273-81.
10. Simion M, Jovanovic SA, Tinti C, Benfenati SP. Long-term evaluation of osseointegrated implants inserted at the time or after vertical ridge augmentation. A retrospective study on 123 implants with 1-5year follow-up. Clin Oral Implants Res 2001;12:35-45.
11. Fugazzotto PA. Success and failure rates of osseointegrated implants in function in regenerated bone for 6 to 51 months: a preliminary report. Int J Oral Maxillofac Implants 1997;12:17-24.
12. Mazzonetto R, Serra E Silva FM, Ribeiro Torezan JF. Clinical assessment of 40 patients subjected to alveolar distraction osteogenesis. Implant Dent 2005;14:149-53.
13. Ergun G, Nagas IC, Yilmaz D, Ozturk M. Prosthetic rehabilitation of edentulous ridges following alveolar distraction osteogenesis: clinical report of three cases. J Oral Implantol 2011;37:183-91.
14. Chiapasco M, Zaniboni M, Rimondini L. Autogenous onlay bone grafts vs. alveolar distraction osteogenesis for the correction of vertically deficient edentulous ridges: a 2-4-year prospective study on humans. Clin Oral Implants Res 2007;18:432-40.
15. Cordaro L, Torsello F, Accorsi Ribeiro C, Liberatore M, Mirisola di Torresanto V. Inlay-onlay grafting for three-dimensional reconstruction of the posterior atrophic maxilla with mandibular bone. Int J Oral Maxillofac Surg 2010;39:350-7.
16. Cordaro L, Amadé DS, Cordaro M. Clinical results of alveolar ridge augmentation with mandibular block bone grafts in partially edentulous patients prior to implant placement. Clin Oral Implants Res 2002;13:103-11.
17. Vega LG, Bilbao A. Alveolar distraction osteogenesis for dental implant preparation: an update. Oral Maxillofac Surg Clin North Am 2010;22:369-85.
18. Szpalski M, Gunzburg R. Recombinant human bone morphogenetic protein-2: A novel osteoinductive alternative to autogenous bone graft? Acta Orthop Belg 2005;71:133-48.
19. Ettl T, Gerlach T, Schüsselbauer T, Gosau M, Reichert TE, Driemel O. Bone resorption and complications in alveolar distraction osteogenesis. Clin Oral Investig 2010;14:481-89.
20. Misch C. The use of ramus grafts for ridge augmentation. Dent Implantol Update 1998;9:41-4.
21. Hunt DR, Jovanovic SA. Autogenous bone harvesting: a chin graft technique for particulate and monocortical bone blocks. Int J Periodontics Restorative Dent 1999;19:165-73.
22. Nissan J, Ghelfan O, Gross O, Priel I, Gross M, Chaushu G. The effect of crown/implant ratio and crown height space on stress distribution in unsplinted implant supporting restorations. J Oral Maxillofac Surg 2011;69:1934-9.
23. Urban IA, Jovanovic SA, Lozada JL. Vertical ridge augmentation using guided bone regeneration (GBR) in three clinical scenarios prior to implant placement: a retrospective study of 35 patients 12 to 72 months after loading. Int J Oral Maxillofac Implants 2009;24:502-10.
24. Wang HL, Boyapati L. "PASS" principles for predictable bone regeneration. Implant Dent 2006;15:8-17.
25. Le B, Rohrer MD, Prasad HS. Screw "tent-pole" grafting technique for reconstruction of large vertical alveolar ridge defects using human mineralized allograft for implant site preparation. J Oral Maxillofac Surg 2010;68:428-35.
26. Simion M, Baldoni M, Rossi P, Zaffe D. A comparative study of the effectiveness of ePTFE membranes with and without early exposure during the healing period. Int J Periodontics Restorative Dent 1994;14:166-80.
27. Machtei EE. The effect of membrane exposure on the outcome of regenerative procedures in humans: A meta-analysis. J Periodontol 2001;72:512-16.
28. Hämmerle CH, Jung RE. Bone augmentation by means of barrier membranes. Periodontology 2000 2003;33:36-53.

Case Report

A Novel Method to Fabricate a Surgical Stent for Free Mucosal Grafting on Reconstructed Mandible

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Abstract

A novel method is described to fabricate the surgical stent for securing the free mucosal graft at the reconstructed mandibles which are covered by thick soft tissue. This procedure uses the computed tomography and stereolithographic replica to replace conventional stone model made from impression. The surgical stent is more accurate and makes the surgical procedure more easily.

Key words：free mucosal graft, computed tomography, stereolithography, surgical stent

Introduction

Acquired mandibular defects usually cause esthetic deformation and functional loss. Free flaps have been proved a successful method to reconstruct composite segmental mandibular defects [1]. Oral rehabilitation can be preformed with an implant retained prosthesis or a conventional removable partial denture (RPD) after free flap surviving. The bulky soft tissue overlying the bone of free flaps should be thinned and even resurfaced with keratinized skin or palatal mucosal graft [2]. Mucosal grafts are preferred because they have better cohesion and adhesion compared to skin grafts [3]. They provide a better tissue-bearing surface for a conventional RPD and decrease the risk of peri-implantitis [4]. A surgical stent is used to protect and immobilize the skin graft or palatal tissue graft [5]. This stent can be retained by the implants or circumferential wires at bonebody. A cast of the mandible is necessary to fabricate a stent before grafting surgery. However, the stent often needs to be relined during surgery because the soft tissue is too thick to register the underlying bony surface. It is difficult and time consuming to perform an ideal intaglio surface.

A technique is presented to make an accurate surgical stent and to decrease the chance of reline during surgery.

Technique

1. Computed tomography (CT) scans the bone morphology at the recipient site. The scan area should include the full height of bone and the adjacent teeth of the recipient site. It helps to determine the border onto which the surgical stent will be extended (Figure 1).
2. The stereolithography (STL) mandibular replica is created from the CT data (DICOM format). The replica should represent the full height of bone and the adjacent teeth of the recipient site. Check and remove irregular spikes on the replica, as this may be digital noise.

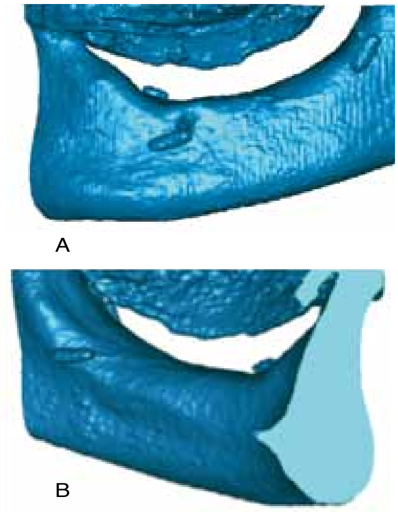

Fig. 1. The CT reconstructive image of recipient site. A, buccal view. B, lingual view.

3. Mark the recipient area and apply a thin layer of petroleum jelly as a separator on the STL replica. Use the clear autopolymerizing orthodontic resin to form a stent covering the marked area on the replica (Figure 2). The thickness of the stent should provide adequate rigidity. After final curing, remove the stent from the replica, trim, polish, and clean the stent (Figure 3).
4. The mucosal graft is sutured on the exposed periosteum after the partial thickness flap is elevated if there is no implant placed at the recipient site. The stent is placed over the mucosal graft and fastened to the underlying bone with circumferential wires. Drill the holes corresponding to the implant positions on the surgical stent if there are osseointegrated implants at the recipient site. Punch the periosteum to expose the implant heads and place healing abutments after elevation of the partial thickness flap. The free mucosal graft is adjusted to adapt to the recipient surface and expose healing abutments. Adjust the holes on the surgical stent for complete seating. Replace the healing abutments to temporary UCLA cylinders and connect the cylinders with autopolymerizing acrylic resin to the stent (Figure 4). Preload the abutment screw with about 10 N-cm to prevent screw loosening during the healing period. The stent is removed to examine the recipient site after 1 to 2 weeks of healing and then reattached.

Discussion

Free mucosal graft should be harvested evenly and in suitable thickness for better tissue support at the recipient site. A layer of wax (2 mm thick) could be placed as a spacer between the stent and the STL replica before fabrication of a surgical stent on the STL replica simulating the uniform space for the graft. The spacer is necessary if the bone shape and surface is irregular or the flange of the stent has to extend vertically more than 10 mm to provide adequate coverage. However the stent will not extend too much depth bucco-lingually if the bone shape and surface is gentle and the bone height is low, like this case. Hence, a wax spacer is not necessary.

In patients with multiple implants at the recipient site, it is adequate and time saving to retain the stent with only 2 or 3 implants because the less temporary UCLA cylinders are needed to be connected. It is also more convenient for the operator to remove the stent for checking. The cervical flare-out contour of the healing abutment or the temporary cylinders could be trimmed off to compress the peri-implant mucosal graft with the surgical stent. The holes on the stent may be too big to fully insert and seat the stent when the implants are not parallel to each other and if the temporary cylinders are connected to the implants first. This will leave the peri-implant mucosal graft compressed inadequately. However, the operator could seat the stent with smaller holes above the implants first and connect the temporary UCLA cylinders and the healing abutments through the holes.

This technique shows that the surgical stent is fabricated on the STL replica. It is possible to design an identical shape of the stent and "print-out" directly with the rapid prototyping technique that is similar to the method to make commercial CAD-CAM surgical guides for implant surgery. However, before developing a new material that can be stable in the oral environment during the healing period, using the conventional denture material is still recommended. The new material could be developed for replacing the autopolymerizing resin in the future.

Conclusion

This novel method is suitable for those grafted mandibles covered by thick soft tissue. The surgical stent is more accurate and makes the surgical procedure easier.

A B

Fig. 2. The stereolithography mandibular replica and the surgical stent. A, buccal view. B, lingual view.

A B

Fig. 3. The surgical stent made of clear autopolymerizing resin. A, polishing surface. B, tissue surface

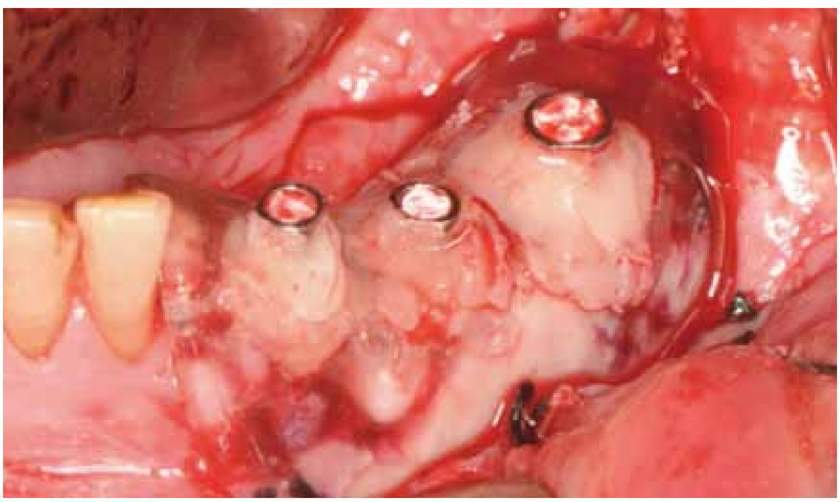

Fig. 4. The surgical stent was connected to temporary UCLA cylinders with autopolymerizing resin to secure the position of underlying mucosal graft.

摘要

在重建之下顎骨進行游離黏膜移植術(free mucosal grafting)時，常需要以手術固定板 (surgical stent) 加以固定移植物。本文介紹一種製作手術固定板的方法，係利用患者之電腦斷層影像 (computed tomography) 轉製成立體光照模型(stereolithographic replica) 取代傳統印模方式所取得的石膏模型，以得到患者受殖區 (recipient site) 的準確外型，在其上製出較精確的手術固定板，使手術流程更加順利。

關鍵詞： 游離黏膜移植、電腦斷層影像、立體光照模型、手術固定板

References

1. Hidalgo DA. Aesthetic improvements in free-flap mandible reconstruction. Plast Reconstr Surg. 1991; 88:574-85.
2. Beumer J, Marunick MT, Esposito SJ. Maxillofacial rehabilitation: Prosthodontic and Surgical Management of Cancer-Related, Acquired, and Congenital Defects of the Head and Neck. 3rd ed. Chicago: Quintessence Publishing. 2011; 127-32.
3. Zarb GA, Bolender CL, Hickey JC, Carlsson GE. Boucher's prosthodontic treatment for edentulous patients. 10th ed. St. Louis: Mosby. 1990; 138-43.
4. Chang YM, Wallace CG, Tsai CY, Shen YF, Hsu YM, Wei FC. Dental implant outcome after primary implantation into double-barreled fibula osteoseptocutaneous free flap-reconstructed mandible. Plast Reconstr Surg. 2011; 128:1220-8.
5. Brygider RM, Bain CA. Custom stent fabrication for free gingival grafts around osseointegrated abutment fixtures. J Prosthet Dent. 1989; 62:320-2.

Case Report

Prosthodontic Treatment of a Patient with Combination Syndrome: A Clinical Case Report

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Abstract

Combination syndrome commonly occurs in patients with a completely edentulous maxilla opposed by a bilateral distal-extension removable partial denture. This syndrome poses a considerable challenge to dentists. The symptoms of the syndrome consist of anterior maxillary bone loss, mandibular bone loss, tuberosity overgrowth, and alveolar ridge canting. All of these effects render prosthetic treatment more difficult, and although it is preferable to use dental implants for functional support, complex cases still require conventional prosthetic treatments for medical or financial reasons.

This clinical report presents the prosthodontic management of a patient exhibiting combination syndrome along with a discussion of relevant literature.

Keywords: Combination syndrome, distal-extension RPD

Introduction

The oral rehabilitation of patients with an edentulous maxilla opposed by natural mandibular anterior teeth is a considerable challenge for many clinicians. These cases pose many potential problems, including loss of bone from the anterior edentulous maxilla and super-eruption of unopposed mandibular anterior teeth. Kelly (1972) proposed the term combination syndrome for this oral condition and its resultant clinical features. The Glossary of Prosthodontic Terms[1] has defined combination syndrome as: the characteristic features that occur when an edentulous maxilla is opposed by natural mandibular anterior teeth, including loss of bone from the anterior portion of the maxillary ridge, overgrowth of the tuberosities, papillary hyperplasia of the hard palatal mucosa, extrusion of mandibular anterior teeth, and loss of alveolar bone and ridge height beneath the posterior mandibular removable dental prosthesis bases – also called anterior hyperfunction syndrome.

Kelly (1972)[2] observed 20 patients equipped with complete maxillary dentures opposing distal-extension removable partial dentures (RPD). After three years of follow-up, six of these patients showed a reduction of the anterior bony ridge height (1.35 ± 0.83 mm) on lateral cephalometric radiography. Meanwhile, an increasing bone level of the tuberosities (1.38 ± 0.36 mm) was noted in five patients. Kelly (1972) proposed the preservation of posterior teeth to support lower partial dentures and a more stable occlusion to avoid combination syndrome. Preservation of posterior occlusion and avoidance of anterior hyperfunction are considered the primary treatment suggestions for this complex condition. Saunder et al (1979)[3] and Jameson (2001)[4] suggested the use of an alternative tooth form and occlusal concept (linear occlusion) and minimum anterior contact for reducing further bone loss caused by hyperfunction of anterior teeth. Previous studies advocated osseointegrated implant-retained or implant-supported prostheses to change the occlusal force distribution and decrease the traumatic stress to the alveolar bone resulting from combination syndrome.[5]

The present report details the prosthodontic management of a specific patient exhibiting symptoms of combination syndrome.

Case Report

A 73-year-old male patient was referred to the Dentistry Department of Taipei Medical University Hospital in Taipei, Taiwan, for restorative treatment. The patient's chief complaints were inadequate retention of maxillary complete denture and inability to chew comfortably. No major systemic diseases or drug allergies were reported. On examination, the patient had an edentulous maxilla and nine natural mandibular anterior teeth (Figure 1). Clinically, the patient displayed anterior bone loss and flabby tissue of the maxillary ridge, overgrowth of the maxillary tuberosities, and over-erupted mandibular anterior teeth (Figure 2). The patient rejected any surgery and implant therapy due to financial considerations. The patient agreed to have a new complete denture and a mandibular removable partial denture

Figure 1. Panoramic radiograph showing a typical case of combination syndrome with severe resorption of the anterior maxillary and super-eruption of unopposed mandibular anterior teeth.

(a)

(b)

(c)

(d)

(e)

Figure 2.: (a) Occlusal view of maxillary arch. (b) Occlusal view of mandibular arch showing tooth crowding. (c) Right-side view revealing the retained canine. (d) Preoperative frontal view showing greater bone resorption of the premaxillary area. (e) Left-side view indicating sufficient restoration space.

after some discussion.

Initial therapy included oral hygiene instructions, caries control, and nonsurgical periodontal therapy. At the first clinical appointment for prosthodontic treatment, a preliminary impression of the maxillary and mandibular arches was made with irreversible hydrocolloid materials (Hydrogum, Zhermack®, Badia Polesine, Italy) and poured with dental stone. A custom tray was fabricated for the maxillary complete denture impression and a wax relief was applied to the anterior flabby tissue area. A green modeling compound (GC Corp, Tokyo, Japan) was then used to obtain accurate denture border position and seal. The definitive impression of the maxillary arch was made with vinyl polysiloxane impression material (Virtual®, Ivoclar Vivadent, Schaan, Italy) (Figure 3a). A definitive cast was created with type III dental stone.

A Kennedy Class I RPD of the mandibular arch was designed after surveying the cast. Following tooth preparation, the definitive impression of the RPD framework was made with vinyl polysiloxane material (Aquasil, Dentsply Caulk, Milford, Delaware, USA). The altered-cast technique was promulgated to improve the stability of the mandibular RPD and correct any errors incurred at the first impression stage. After the face-bow transfer, the maxillary and mandibular master casts were mounted in centric relation on a semi-adjustable articulator (Whip Mix 3040, Louisville, Kentucky, USA). In addition, an intraoral Gothic Arch Tracer (Simplex®, Dentsply, New York, USA) was applied to verify accurate and reproducible occlusal vertical dimension (OVD) and centric relation (CR)(Figure 3c).

The selection of maxillary anterior artificial teeth was determined by patient gender and personality. Balanced occlusion was indicated for this case to assure an even distribution of occlusal force and prevent occlusal interferences on the residual ridge. The tooth arrangement was checked for esthetics and CR position and then submitted for processing. After prescrip, both casts were remounted, adjusted, and polished. At a subsequent appointment, the finished prostheses were delivered and minimal occlusal adjustment was needed. The patient was pleased with their appearance and chewing ability. A maintenance program including oral hygiene instruction and prosthesis home care was established. At the 18-month maintenance visit, no complications were observed.

Discussion

Treatment of patients with an edentulous maxilla opposed to natural mandibular anterior teeth and a distal-extension RPD is considered a challenge for dental practitioners. Combination syndrome has a prevalence rate

(a) (b) (c)

Figure 3.: (a) Maxillary impression prepared by mucostatic impression technique. (b) Altered-cast impression for the distal-extension RPD. (c) Gothic arch tracer was applied to record the CR position.

(a) (b) (c)

Figure 4.: Frontal and lateral views of the finished prostheses at the time of delivery. Even occlusal contacts and minimum anterior contacts were provided for this case.

of approximately 24% for denture patients[6]. Therefore, it is necessary for dentists to understand the particular problems of patients and provide a comprehensive treatment plan.

Increasing pressure on the premaxillary alveolar ridge and loss of adequate posterior occlusal contacts are important factors in relation to combination syndrome[6, 7]. The bone loss in the midline of the maxilla observed by Kelly (1972) was 0.43 mm/year. López-Roldán etal (2009)[8] and Barber etal (1990)[9] reported similar results (0.32 mm/year and 0.36 mm/year, respectively) among patients wearing a maxillary complete denture and mandibular overdentures on two implants, a situation in which the prosthetics are biomechanically similar to Kelly's cases. Maximum support of the denture-bearing area, preservation of the mandibular posterior abutment, and balanced occlusion were all proposed to prevent bone loss and excess pressure on the anterior maxillary alveolar ridge. Similarly, Van Waas etal (1993)[10] suggested the avoidance of total tooth extraction, the preservation of a few teeth, and the use of overdentures.

In the present case, the mucostatic impression technique with relief at the anterior maxillary flabby tissue was applied to accurately record the entire functional denture-bearing area (Figure 3a). In addition, the maxillary right canine root was retained for preservation of alveolar bone and proprioception. Meanwhile, a proper occlusal plane, the balancing of tooth contacts during excursive movements, the elimination of anterior contacts, and remounting techniques were used to gain better distribution of occlusal force and reduce stress on the anterior maxillary alveolar ridge.

The effect of mandibular status on maxillary ridge resorption has been widely discussed and investigated. Carlsson etal (1967)[11] compared bone resorption of the anterior maxillary alveolar ridge among patients with maxillary complete dentures and three different mandibular statuses: (1) a mandibular complete denture; (2) mandibular anterior teeth with bilateral extension RPD; and (3) mandibular teeth only. Greater bone resorption was found in the groups that had anterior mandibular teeth with or without an RPD when compared to the group with mandibular teeth only. However, small and insignificant changes of the bone height were described over five-years of follow-up in patients with a maxillary complete denture opposed by a bar-retained mandibular RPD[12]. Other studies[13, 14] showed no significant differences and proposed that the individual variations were larger, but the experimental data revealed that greater bone resorption occurred among patients with unilateral or bilateral RPD. To prevent the occlusal and enhance the treatment of cs, we propose that (1) the distal-extension mandibular RPD may serve a negative role for the deterioration of combination syndrome[15]; and (2) the application of dental implants in edentulous areas, especially at premolar or molar regions, could provide better posterior support[16].

References

1. The glossary of prosthodontic terms. J Prosthet Dent 2005; 94: 10-92.
2. Kelly E. Changes caused by a mandibular removable partial denture opposing a maxillary complete denture. J Prosthet Dent 1972; 27: 140-50.
3. Saunders TR, Gillis RE Jr, Desjardins RP. The maxillary complete denture opposing the mandibular bilateral distal-extension partial denture: treatment considerations. J Prosthet Dent 1979; 41: 124-8.
4. Jameson WS. The use of linear occlusion to treat a patient with combination syndrome: a clinical report. J Prosthet Dent 2001; 85: 15-9.
5. Tolstunov L. Management of biomechanical complication of implant-supported restoration of a patient with combination syndrome: a case report. J Oral Maxillofac Surg. 2009; 67: 178-88.
6. Shen K, Gongloff RK. Prevalence of the 'combination syndrome' among denture patients. J Prosthet Dent 1989; 62: 642-4.
7. Palmqvist S, Carlsson GE, Owall B. The combination syndrome: a literature review. J Prosthet Dent 2003; 90: 270-5.
8. López-Roldán A, Abad DS, Bertomeu IG, Castillo EG, Otaolaurruch ES. Bone resorption processes in patients wearing overdentures. A 6-years retrospective study. Med Oral Patol Oral Cir Bucal 2009; 14: 203-9.
9. Barber HD, Scott RF, Maxson BB, Fonseca RJ. Evaluation of anterior maxillary alveolar ridge resorption when opposed by the transmandibular implant. J Oral Maxillofac Surg 1990; 48: 1283-7.
10. Van Waas MA, Jonkman RE, Kalk W, Van 't Hof MA, Plooij J, Van Os JH. Differences two years after tooth extraction in mandibular bone reduction in patients treated with immediate overdentures or with immediate complete dentures. J Dent Res 1993; 72: 1001-4.
11. Carlsson GE, Bergman B, Hedegård B. Changes in contour of the maxillary alveolar process under immediate dentures. A longitudinal clinical and x-ray cephalometric study covering 5 years. Acta Odontol Scand 1967; 25: 45-75.
12. Uçta li S, Hasanreiso lu U, I eri H. Cephalometric evaluation of maxillary complete, mandibular fixed-removable partial prosthesis: a 5-year longitudinal study. J Oral Rehabil 1997; 24:164-9.
13. Crum RJ, Rooney GE Jr. Alveolar bone loss in overdentures: a 5-year study. J Prosthet Dent 1978; 40: 610-3.
14. Tallgren A. The continuing reduction of the residual alveolar ridges in complete denture wearers: a mixed-longitudinal study covering 25 years. J Prosthet Dent 1972; 27: 120-32.
15. Palmqvist S, Carlsson GE, Owall B. The combination syndrome: a literature review. J Prosthet Dent 2003; 90: 270-5.
16. Keltjens HM, Kayser AF, Hertel R, Battistuzzi PG. Distal extension removable partial dentures supported by implants and residual teeth: considerations and case reports. Int J Oral Maxillofac Implants 1993; 8: 208-13.
17. Carlsson GE. Responses of jawbone to pressure. Gerodontology 2004; 21: 65-70.

Technical Report

Alveolar Tunneling Suture Technique of Flap Stabilization

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Abstract

Background: *When a corrective periodontal surgery is indicated to assist fabricating a definite prosthesis or restoration, some encountered tribulations from flap management, wound closure, and keratinized tissues preservation are required to be settled. In order to handle these complexities, a modified suture technique, alveolar tunneling technique, is proposed to facilitate flap manipulation.* ***Materials and Methods:*** *Three cases requiring a crown lengthening procedure were presented in this report. After processing the routine dental examination, evaluation and periodontal cause-related treatment, a crown length mix procedure was applied and the flaps were stabilized using the alveolar tunneling suture technique. Preoperatively and postoperatively, the width of keratinized gingiva and the pocket probing depth were measured and recorded. The findings on radiographs were also compared. A final prosthesis was delivered at least 3 months later, followed by supportive periodontal therapy.* ***Results:*** *The therapeutic effects of the applied suture technique include a better bleeding control, a decreased hematoma formation at the dead space, an established definite position of a flap, a secured mucosa or flap, and a preserved keratinized gingiva. A predictable wound healing can therefore be enhanced. Nevertheless, some disadvantages such as extra alveolar bone preparation, technique sensitivity, more time consumption, anatomic limitation, mild postoperative discomfort, soft tissues pull, and cheek biting in molar area may occur.* ***Conclusion:*** *A satisfactory treatment outcome of the periodontal procedure of which flaps are managed carefully according to the described alveolar tunneling technique can be achieved. However, the clinical and histological implications of this modified approach on wound healing of soft and hard tissues require further investigation.* ***Clinical relevance：*** *To stabilize the flap tissues is not an easy task during periodontal operation. The aim of this case report was to present a novel technique (alveolar tunneling technique) to assist flap stabilization and to position the flap accurately onto an intended location. In such way, it may assist in bleeding control, decrease hematoma formation from the dead space at the surgery site, establish a definite position of flap, secure a mobile mucosa or flap, and preserve almost all keratinized gingiva. A better wound healing can therefore be enhanced.*

Keywords: alveolar tunneling technique; apical positioned flap; crown lengthening procedure; keratinized gingiva.

Introduction

A prosthodontic-periodontal surgery is indicated once the interfering situations such as subgingival decay, a short clinical crown, a fractured tooth or esthetic demands are encountered that prevent fabricating a definite restoration [1]. With interrelated periodontal flap operations, including distal wedge, apically positioned flap, crown lengthening procedure or gingivectomy, a subtle and atraumatic flap management is important for the treatment outcome. Whatever the reasons for a periodontal surgery, an open wound must be properly debrided, irrigated and sutured when a planned surgical practice is accomplished. There are multiple purposes for retrieving the reflected mucoperiosteal flap[2]. One intention is to retain soft tissues in apposition with the bone to promote wound healing. The reunited flap may assist the formation and maintenance of blood clots, by which a potential aggressive postoperative bleeding or a hematoma is prevented. The wound with an exposed bone could evoke worse postoperative pain, and the entrance of food debris into a surgical site may induce possible postoperative infections or contaminations that delay healing. These complications can be avoided when the open wound is well protected and closed[3].

Less keratinized tissues are noted around the buccal and lingual gingiva of the mandibular molars[4]. The soft tissues immediately distal to the mandibular terminal molar consists of a small retromolar papilla, situated in varying proximities to the base of the anterior border of the ramus. The specific anatomic and histological characteristics of retromolar pad tissues contain an aggregation of loose fatty tissues and glands but little fibrous attached gingiva. The retromolar papilla extends distally into the prominent loosely attached mucosa, glands, muscle and connective tissues, and forms the base of the cheek. In many cases, the treatment of periodontal pockets and subgingival dental caries on the distal surface of the last molar is complicated by the presence of bulbous tissues over a prominent retromolar pad. Various surgical techniques have been proposed to facilitate accessing and modifying the soft and hard tissues, such as the distal wedge procedure[5] and the modified distal wedge procedure[6] .

Due to the limitation to be approached and the extensive loose cheek tissues at the retromolar area, precise flap management and fixation is always complicated and unpredictable. It has been reported that the high rebounding rate of soft tissues and the mean distance between the restoration of the tooth and bone crest is 2.4 mm instead of 3.0 mm post-operatively[7]. Another study showed the mean tensile strength needed to detach the flap from dentin was markedly weaker than that from bone at all testing time points, while the tensile strength of both flaps significantly increased after the seventh day of healing and continued to be improved thereafter[8]. These findings imply that the routine schedule for suture removal at one week after surgery may not be long enough for flap stabilization, especially since the healing between the tissues and dentine requires an even longer period of time. In addition, a stronger flap fixation is therefore indicated.

Stabilizing the flap tissues at the end of the operation by anchoring a detached flap onto the alveolar bone in the oral cavity through suturing has not yet been reported. In this report, we presented a novel technique (alveolar tunneling technique) to assist flap stabilization and to position the flap accurately onto an intended location. The possible advantages and complications are also discussed.

Case description

Three Asian patients with non-contributory medical histories and non-smoking habits were referred to the Periodontics Department in Chang-Gung Memorial Hospital for a Prosthetic-Periodontal evaluation and treatment. Preceding the clinical and radiographic examination, diagnosis, consultation and treatment planning, the indications for the intervention of periodontal surgery were confirmed. A cause-related therapy, including oral hygiene instructions and plaque control, was accomplished and a signed informed consent was obtained prior to the operation. The patients were instructed to rinse for one minute with 0.12% chlorhexidine (Scodyl, Beauteeth Company Ltd, Taiwan). The flap, a full thickness design, was elevated over the mucogingival junction and a mucoperiosteal flap followed. During surgery, following an adequate anesthesia, an incision was made, flaps were reflected, granulation tissues

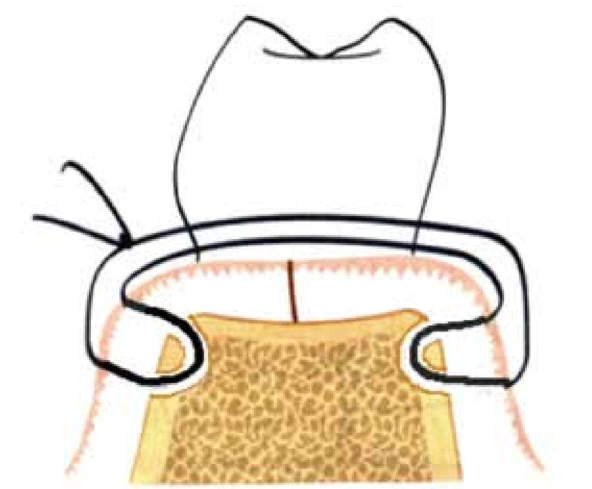


Fig 1 A “) ” shape alveolar tunnel can be created with No. 520 round bur at buccal or lingual site in a safe distance away from the proximal tooth.

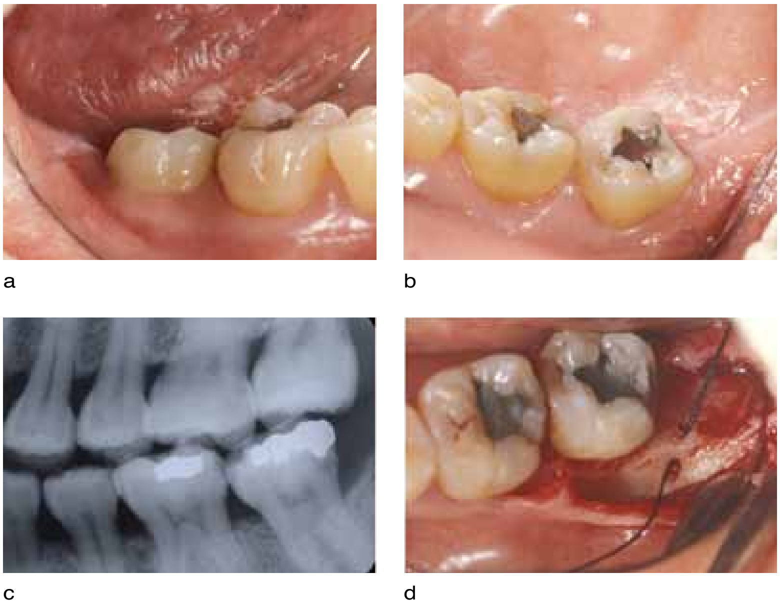
were removed, the root was planed, osseous resection/plastic was performed, the alveolar tunnel was made (Fig 1) and the wound was closed by suturing. Stitches were removed 10 to 14 days postoperatively. Amoxicillin 500mg, t.i.d for seven days, if a bone graft was applied, and Scanol® 400mg, q.i.d for seven days, were prescribed post operatively. Also, a regimen of 0.12% chlorhexidine rinse b.i.d was utilized for 3-4 weeks following the surgery. The patient after that received periodontal maintenance was recalled once every three months. Preoperatively and postoperatively, the width of keratinized gingiva and the pocket probing depths were measured and recorded. The findings on periodical radiographs were also compared.

Case one

The 44–year-old otherwise healthy female patient complained that her tooth #37 was sensitive to cold water and she had a swollen gingiva. Several findings were observed after examination, including a secondary caries apical to the amalgam restoration extended to subgingival 2.0-3.0 mm in this lingual tilting secondary molar (Fig 2a, 2b, 2c). Swollen retromolar tissues and a 6.0-7.0 mm probing pocket depth at distal site of the tooth were also noticed. In order to expose the defect to repair the impaired restoration, to remove the excessive soft tissues for better oral hygiene accessibility and to perform a flap operation for decreasing pocket depth, a crown lengthening procedure was indicated. The measured keratinized gingiva was 2.0-3.0 mm at the buccal site, 3.0-4.0 mm at the lingual location and 1.0-2.0 mm at the retromolar position. The decay was temporary filled with Ketac Silver[++] to prevent the tooth from becoming sensitive (Fig 2a). Intrasucular incisions were made from tooth #37 to tooth #36 at both buccal and lingual aspects[9] (Fig 2d). A trap door technique instead of a traditional distal wedge was carried out at the distal side of tooth #37[10]. After trimming away the undermine connective tissues, a full thickness with a mucoperiosteal flap was reflected for better and passive wound closure[11]. When the interested field was exposed, a 4.0 mm infrabony defect and a tooth defect were noted at the distal side of tooth #37. A thorough degranulation, root planning and an osseous plastic surgery with autogenous bone graft were carried out to eliminate the bony defect and to re-establish enough accommodation for a biological width[12,13,14]. A “) ” shape tunnel was created with a no. 520[+*] round bur at a safe distance of 3.0 mm away from the tooth (Fig 2d). Since the size and shape of the tunnel depends on the type of needle used for wound closure, a No. P3 needle shaped tunnel was created and a 4-0 Vicryl® suture was applied (Fig 2e). The wound was protected with COE-PAK™ packing. The patient returned one week later for oral hygiene reinforcement and examination. The suture was removed after 14 days and recalls took place once a month for three months. The wound healing was normal and the 2.0-3.0 mm limited keratinized gingiva persisted. The probing depth at distal side of the tooth decreased to 3.0 mm. The shallow vestibular did not deteriorate (Fig 2f).

Case two

A 26–year-old male patient was referred from the Prosthodontic Department for evaluation and treatment of mesial shifting and a tilting tooth #48. An undermine caries was found before the original fixed partial prosthesis was discarded. The severely damaged tooth structure amplified the challenge to rehabilitate a healthy, functional and aesthetic restoration (Fig 3a). A crown lengthening procedure with apically placed flap was required to expose more tooth structure to enhance essential retention for the renewed 3-unit bridge. No significant mobility was detected for the involved teeth. A 3.0-4.0 mm probing depth around the tooth



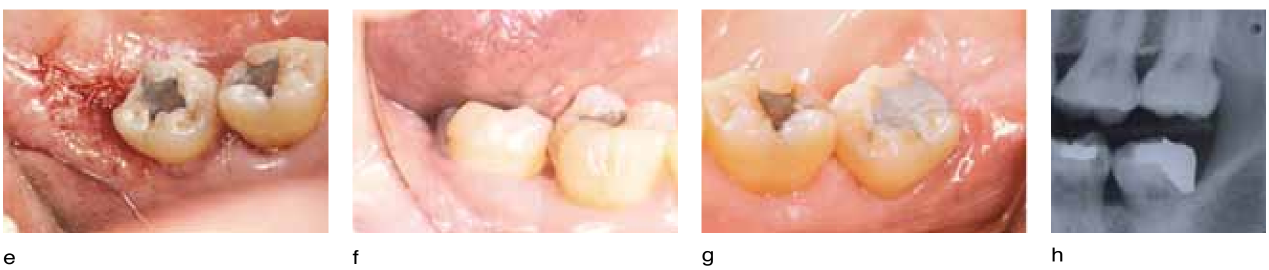


Fig 2 A lingual tilting tooth #37 with secondary caries was noted. Preoperatively, the decay was temporarily filled with Ketac Silver. (a) buccal view of tooth #37,(b) lingual view of tooth #37, and (c) the bite-wing radiograph showed a secondary caries extended 2-3 mm into subgingival tissues before Ketac Silver temporary filling. (d) Subsequent to reflecting buccal and lingual full thickness flaps from tooth #36 to #37 and removing the granulation tissues at distal wedge, osseous resection and plastic were performed. A 3 mm distance from crest to caries margin was established for the accommodation of biological width and an alveolar tunnel was created at distal buccal site - sewed by a 3-0 silk suture. (e) Wound was closed with a 4-0 Vicryl suture. (f) Post-operative buccal view of the surgery site 3 months later. (g) lingual view. (h) vertical bite wing radiography.

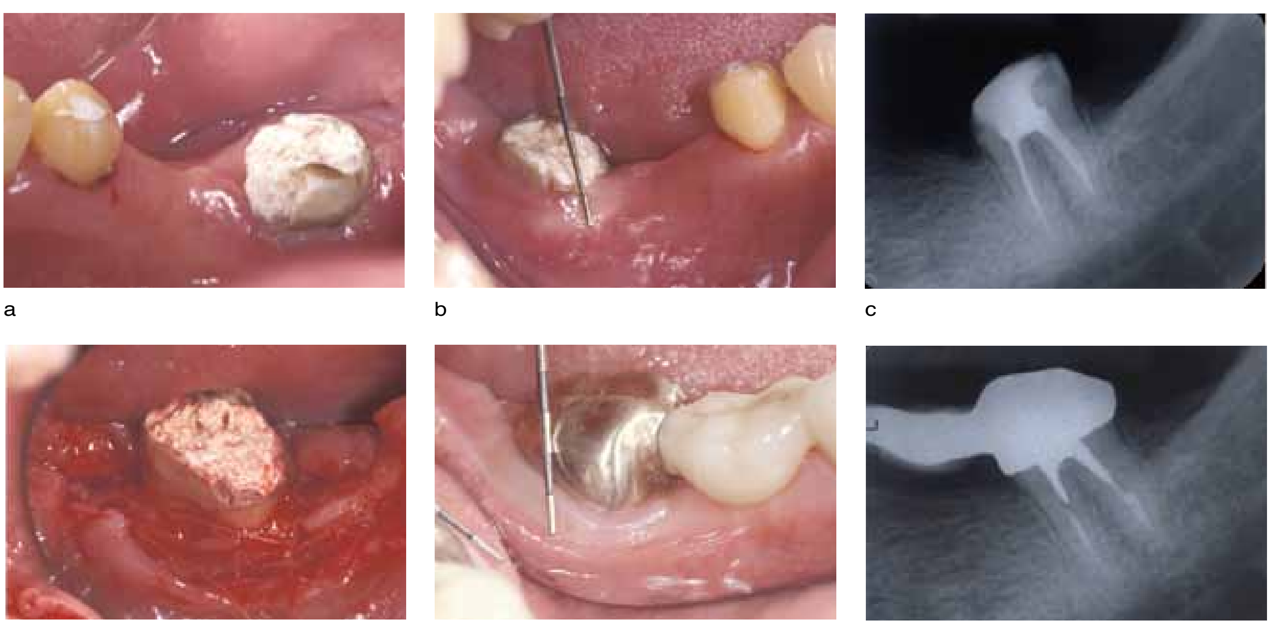


Fig 3 (a) A mesially shifting and tilting tooth #48 presented an extensive decay on short clinical crown that extended subgingivally. (b) A 3 mm wide keratinized gingival at the buccal surface was noted. (c) X-ray shows insufficient biological width at mesial margin. (d) Two alveolar tunnels were prepared in a safe distance 2.0 mm away from the tooth at both mesial and distal sides, then; the flaps were repositioned apically and stabilized by a vertical mattress 4-0 Vicryl® suture that passed through the tunnels. (e) Three to four months later, a final prosthesis was delivered and the same 3.0 mm keratinized gingival was preserve. (f) Post-operative radiograph demonstrated a normal healing pattern of alveolar bone.

and a 3.0 mm width keratinized gingiva at the buccal surface was noted (Fig 3b). A mid-crestal incision from distal tooth #45 to tooth #48 was made initially and an intrasucular incision around tooth #48 and a distal wedge followed. Releasing incisions of the flap were made mesially and distally. Subsequent to elevating the planned flap, granulation tissues were removed, the root surface was planed and a 3.0 mm accommodating zone for biological width was created. A tunnel was generated with a No. 520 round bur at a 2.0 mm safe distance away from the tooth mesially and distally. The flap was repositioned apically and stabilized by a vertical mattress 4-0 Vicryl® suture that passed through the alveolar tunnel (Fig 3c). Suture removal and the following recalls were held according to the schedule (Fig 3d). A permanent prosthesis was provided four months later. A normal healing pattern without complication took place. The same 3.0 mm keratinized gingiva and probing depth were retained (Fig 3e, 3f).

Case three

A 26–year-old male in generally good health asked for a prosthesis replacement of his upper anterior teeth because of gingival recession and the metal color of the prosthesis had begun to show through (Fig 4a). Secondary subgingival caries associated with the prosthesis were found on pre-operative radiograph (Fig 4b). After removing the ill-fitting prosthesis, short clinical crowns with a biological width violation and subgingival finishing margin were found at teeth #12 and #11(Fig 4c). A crown lengthening procedure combined with an apically positioned flap from tooth #13 to tooth #23 was planned to reestablish a healthy biological width and an aesthetic smile line[12,13,14]. Intra-oral examination revealed no significant mobility for all of the involved teeth. A 3.0-4.0 mm acceptable probing depth around the teeth and a 5.0 mm width keratinized gingival tissue at buccal surface were noted. Intrasucular incisions were made from tooth #14 to tooth #24 at both buccal and lingual sides. Two vertical incisions at the distal-buccal line angle of teeth #13 and #23 were made. A full thickness with a mucoperiosteal flap was lifted. Subsequent to degranulation, root planing and osseous resection/plastic, a 3.0 mm distance from alveolar crest to the prepared margin was established to restore enough space for a biological width. A tunnel was created with a no. 4 round bur at a 1.0 mm safe distance away from the tooth (Fig 4d). The flap was repositioned apically and stabilized by a 4-0 Vicryl® suture that passed through the alveolar tunnel and secured the flap with a vertical mattress tie (Fig 4e). The suture was removed

a b c d

e f

Fig 4 (a) Clinical frontal appearances of upper anterior teeth illustrated an inflammatory gingiva. (b) Secondary subgingival caries were found on pre-operative radiograph. (c) Biological width violation and short clinical crowns were noted after removing ill-fitted prosthesis.(d) A crown lengthening procedure from tooth #13 to tooth #23 was carried out to reestablish a biological width and an aesthetic smile line. Alveolar tunnels, showed by a 3-0 silk suture, were created and were kept a 1.0-2.0 mm safe distance away from the teeth. (e) The flap was repositioned precisely and stabilized by a 4-0 Vicryl® suture that passed through the alveolar tunnel. (f) Permanent crowns were provide four months later and a healthy keratinized gingiva was retained.

after 14 days and recalls were held once every three months. Permanent crowns were delivered four months later (Fig 4f). Healing was within normal limits. There were no noted complications and oral aesthetics, health and function have improved. In addition, almost the same 5.0 mm keratinized gingiva and 3.0-4.0 mm probing depth were retained (Fig 6f).

Discussion

Crown lengthening can be used for esthetic reason or teeth with subginigval destruction, such as caries or fracture. By using this technique we are able to establish biological width and ensure ferrule length. It has been confirmed that if the distance between the margin of restoration and the osseous crest is less than 3 mm, it can cause chronic inflammation and has the risk of losing periodontal attachment and, eventually, bone resorption. Crown lengthening technique can help recreate enough distance to maintain biological width to avoid this problem. If the tooth in need of restoration has poor clinical crown structure, we often find the restoration fall off or fracture again easily. This would happen if the crown fabrication process fails to provide enough tooth structure at apical one third of preparation. The occlusal forces may transmit to the interface of post and root, and in turn causes the cement to become fatigue and post dislodgement or crown fracture. It is important to have enough tooth structural ferrule length (1-2 mm circumferentially) to resist the occlusal stress concentration at this area.

The mandibular retromolar area is formed by a flat buccal shelf and creates a shallow vestibular fornix. The inherent architecture of the retromolar area makes it difficult to be accessed and managed during periodontal surgery. How to achieve a harmonized physiologic bony architecture depends on the alveolar bone management and surgical flap reposition. According to the purposes of periodontal therapy, the retracted flaps may be repositioned or replaced (e.g. apically positioned, coronally positioned, or laterally positioned) along with specific operative techniques[15]. If keratinized gingival tissues are minimal, or once the keratinized gingival tissues are minimized after surgery, their preservation is strongly indicated.

The tensile strength of the tooth-gingival flap interface following periodontal flap surgery in dogs increased from about 200 g on the third day to 340 g after 5-7 days and to more than 1700 g in two weeks[16]. This information implied that the wound integrity relied mainly on the stabilization of the periodontal flap provided by suturing during the early healing phase. Consequently, for periodontal flap surgery, the choice of suture material, placement and removal should be emphasized on protecting the wound from plaque colonization, infection and trauma from oral hygiene procedures[15].

There are many surgical principles that must be complied with to achieve a satisfactory outcome of an operation. The final location of flap should be well secured to promote an optimized wound healing. However, if the flap is pulled and anchored in a situation beyond the passive appropriateness, the created tension on the flap potentially not only interferes with blood supply for the healing periodontium, but also cause the adapted tissues to be pulled through by stitches and create an open wound that induces impeded wound healing and compromised treatment results. Under most circumstances, it is better to decide the final location of flaps before the beginning of the surgery whenever possible. This novel suture technique offers an alternative option to neutralizing some produced tensile strength of the dragged flaps.

The most evident and significant function that sutures afford is to hold the flap into position and approximate the two wound edges. If the space between the two wound edges is minimal, a fast and completed wound healing by primary intention can be achieved.

If the bleeding in the underlying tissues continues, the surface mucosa or skin would not be closed and the formation of a hematoma would occur. Sutures not only help homeostasis, but also assist holding the soft tissue flap over the bone. This is an extremely important function, since the bone that is not covered by the soft tissues will become non-vital and the wound healing requires an extremely long time. That's why unless an appropriate suture technique is employed, the flap may retract away from the bone and expose it and result in delayed healing and possibly infection.

In an oral cavity, the induced response of gingival and mucosa tissues to the placed stitch is different from the responses observed at other experimented sites. The humid and infectious environment of the oral cavity may cause bacterial migration along the sutures into the tissue [17] and there is more persistent and progressive inflammatory reaction associated with remaining sutures than in the skin. In addition, a rapid epithelial invagination was also observed[15,18]. An epithelial migration or bacterial invasion along the sutures into the created alveolar tunnel by this method is therefore possible; however, the implicative healing pattern needs to be confirmed by histology. The suture material and the timing of suture removal may play an important role in wound healing. Silk* is a popular suture material that is extensively used in oral and periodontal surgery. However, it has been reported that silk can clinically and histologically cause a more intense and prolonged inflammatory reaction than most pertinent alternatives[15,19, 20]. Meanwhile, braided sutures tend to encourage more bacterial migration into the connective tissues than monofilament sutures. The cellular and immunologic defense against the invasion related to the braided material is considerably compromised [21]. In a study on beagles, more evident inflammation was noted in the vestibular mucosa than in the mandibular ridge area at all tested time points and in the examined suture materials[15]. In general, instead of the routinely used braided silk suture, a polyglactin-made suture may be a better choice for regions such as a mandibular retromolar pad[19,22].

Flap management with the assistance of the alveolar tunneling technique provides some noted advantages: it may assist in stopping bleeding, decrease a hematoma fomation in the dead space at the surgery site, establish a definite position of flap, secure a mobile mucosa or flap, and preserve almost all keratinized gingiva. A better wound healing can therefore be enhanced.

To date, the alveolar tunneling technique has been applied into the conditions where an apically positioned flap, a reposition flap, a disposition flap and additional flap stabilization are required. It has also been applied in securing a loose or replanted tooth during surgery. An acceptable clinical result can be achieved. Nevertheless, this technique is contraindicated for a compromised wound healing patient, a situation with an anatomical limitation (such as roots proximity, thin alveolar bone, etc.), a shortage of keratinized gingiva, insufficient quality and quantity of alveolar bone, and weak practitioner expertise. Some disadvantages have been uncovered, including extra alveolar bone preparation, technique sensitivity, time consumption, anatomy limitation and a primary wound closure that may be difficult at the interproximal areas when the flap is extensively apically positioned.

Some complaints and side effects have been induced postoperatively, for instance, mild discomfort, soft tissue pull, and cheek biting (especially in the molar area). Meanwhile, a possible alveolar resorption caused by tunnel preparation may occur. This may not be detected on the follow up radiography. The reason for soft tissue pulling or a tight feeling could be originated from an insufficient passive position or a flap release. Similar findings in the field of plastic surgery have been reported. The trap door technique may cause more scar tissue than other suture techniques. Moreover, the complications mentioned tended to decrease or disappear with time. The long term results of this technique still need to be verified.

Conclusions

This case report presented a modified suture technique to assist keratinized gingiva preservation and to stabilize the flexible flaps in a preferable position. An optimized clinical result can be achieved. However, the clinical and histological inferences of this adapted practice on soft and bone tissues wound healing remain to be further investigated. Satisfactory clinical outcomes of this periodontal procedure, in which flaps are managed according to the described alveolar tunneling technique, can be achieved on the condition that enough attention is given and precautions are taken.

* Vicryl® suture-Absorbable synthetic material: polyglactin 910 Coated Vicryl, undyed braided, #4-0, cutting needle P-3, Ethicon

** Nonabsorbable organic material: silk (black braided silk, #4-0, cutting needle, P-3, Ethicon)

+* No 520 round bur: size1/4, diameter 0.5mm

+++ Restorative material: Ketac™ Silver Aplicap (silver-reinforced glass ionomer restorative material, 3M ESPE)

摘要

背景：當必須施行牙周修形手術以協助製作正式贋復體或填補物時，常常會遭遇到如手術翻瓣處理，傷口的關閉以及角化組織的保留上的困難。為能因應這些複雜的問題，在此我們提出一有助翻瓣處理的改良縫合技術(齒槽骨隧道技術)。

技術與方法：在本報告中我們呈現三個需要牙冠增長手術的案例。在進行例行的牙齒檢查及牙周相關的評估與治療之後，施以牙冠增長混合手術，並運用齒槽骨隧道技術以固定皮瓣。術前與術後角化牙齦的寬度及牙周囊袋深度均予以測量與紀錄，並比較X光攝影的結果。三個月後為病患裝上正式的假牙並給與例行之支持性牙周治療。

結果：運用齒槽骨隧道技術的療效包含對流血量有較佳的控制，能減少封閉區域內血腫的形成，最終皮瓣位置的建立，黏膜或皮瓣的穩固與角化牙齦的保留。從而加強可預測的愈後結果。然而額外的齒槽骨修形，技術的敏感度，需要較長的手術時間，結構上的限制，輕微的術後不適，軟組織的拉扯，及臼齒區域的會咬到臉頰則有可能發生式奇必須注意的。

結論：當齒槽骨隧道技術被小心的運用在翻瓣手術上可以得到令人滿意的成效。然而此改良技術在臨床上及組織學上對軟硬組織的傷口愈合仍須進一步的探討。

關鍵詞： 齒槽穿孔術、齦瓣根尖置位、牙冠增長術、角質化牙齦

References

1. Rosenberg, E.S., Cho, S.C. & Garber, D.A. Crown lengthening revisited. Compendium of Continuing Education in Dentistry 1999; 20: 527-32.
2. Archer, W.H. Dentoalveolar surgery: the extraction of teeth. In: Archer. (ed.) Oral and Maxillofacial Surgery 5th ed., 1975; Vol 1: pp 15-134.
3. McDonnel, l.H.T. & Mills, M. Principles and practice of periodontal surgery. In: LF, R., BL, M., RJ, G. & DW, C. (ed.) Periodontics Medicine, Surgery, and Implants. Elsevier Mosby, 2004; pp 358-404.
4. Lindhe, J., Karring, T. & Araujo, M. Anatomy of the periodontium. In: Lindhe, J., Karring, T. & Lang, N. (ed.)Clinical Periodontology and Implant Dentistry 4th ed., Blackwell, Oxford ,UK; Malden,MA. 2003; pp 19-68.
5. Robinson, R.E. The distal wedge operation. Periodontics 1966; 4: 256-64.
6. Pollack, R.P. Modified distal wedge procedure. Journal of Periodontology 1980; 51: 513-5.
7. Herrero, F., Scott, J.B., Maropis, P.S. & Yukna, R.A. Clinical comparison of desired versus actual amount of surgical crown lengthening. Journal of Periodontology 1995; 66: 568-71.
8. Werfully, S., Areibi, G., Toner, M., Bergquist, J., Walker, J., Renvert, S. & Claffey, N. Tensile strength, histological and immunohistochemical observations of periodontal wound healing in the dog. Journal of Periodontal Research 2002; 37: 366-74.
9. Pippin, D.J. Fate of pocket epithelium in an apically positioned flap. Journal of Clinical Periodontology 1990; 17: 385-91.
10. Scharf, D.R. & Tarnow, D.P. Modified roll technique for localized alveolar ridge augmentation. International Journal of Periodontics & Restorative Dentistry 1992; 12: 415-25.
11. Carranza, F.A. & Takei, H.H. The periodontal flap. In: Carranza's Clinical Periodontology, Saunders, 2002; pp762-73.
12. Carranza, F.A. & Takei, H.H. The flap technique for pocket therapy. In Carranza's Clinical Periodontology, Saunders, 2002; pp774-85.
13. Lang, N.P. & Loe, H. The relationship between the width of keratinized gingiva and gingival health. Journal of Periodontology 1972; 43: 623-7.
14. Wennstrom, J. & Lindhe, J. Plaque-induced gingival inflammation in the absence of attached gingiva in dogs. Journal of Clinical Periodontology 1983; 10: 266-76.
15. Selvig, K.A., Biagiotti, G.R., Leknes, K.N. & Wikesjo, U.M. Oral tissue reactions to suture materials. International Journal of Periodontics & Restorative Dentistry 1998; 18: 474-87.
16. Hiatt, W.H., Stallard, R.E., Butler, E.D. & Badgett, B. Repair following mucoperiosteal flap surgery with full gingival retention. Journal of Periodontology 1968; 39: 11-6.
17. Lilly, G.E., Osbon, D.B., Hutchinson, R.A. & Heflich, R.H. Clinical and bacteriologic aspects of polyglycolic acid sutures. Journal of Oral Surgery 1973; 31: 103-5.
18. Ordman, L.J. & Gillman, T. Studies in the healing of cutaneous wounds. II. The healing of epidermal, appendageal, and dermal injuries inflicted by suture needles and by the suture material in the skin of pigs. Archives of Surgery 1966; 93: 883-910.
19. Castelli, W.A., Nasjleti, C.E., Caffesse, R.E. & Diaz-Perez, R. Gingival response to silk, cotton, and nylon suture materials. Oral Surgery, Oral Medicine, Oral Pathology 1978;45: 179-85.
20. Lilly, G.E., Cutcher, J.L., Jones, J.C. & Armstrong, J.H. Reaction of oral tissues to suture materials. IV. Oral Surgery, Oral Medicine, Oral Pathology 1972; 33: 152-7.
21. Blomstedt, B., Osterberg, B. & Bergstrand, A. Suture material and bacterial transport. An experimental study. Acta Chirurgica Scandinavica, 1977; 143: 71-3.
22. Wallace, W.R., Maxwell, G.R. & Cavalaris, C.J. Comparison of polyglycolic acid suture to black silk, chromic, and plain catgut in human oral tissues. Journal of Oral Surgery 1970; 28: 739-46.

Topical Review

上顎前牙區立即性單顆植牙文獻回顧

Immediate Placement of Anterior Maxillary Single-Tooth Implant : Literature Review

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Traditional guidelines suggested that 2 to 3 months of alveolar ridge remodeling following tooth extraction and an additional 3 to 6 months of load-free healing after implant insertion are needed for osseointegration to take place. However, nowadays immediate placement and immediate loading do not interfere the process of osseointegration. To achieve osseointegration, the level of micromotion should be kept below a certain tolerance threshold. Upper anterior single immediate placement of dental implants at the time of tooth extraction has yielded favorable and predictable results. Advantages include better bone and soft tissue preservation, reduced postoperative pain, significant reduction of clinical chair time, and greater patient acceptance. Apart from time gain, another rationale for immediate implantation and provisionalization is the potential to maximally preserve hard and soft tissues, which may be beneficial to the esthetic treatment outcome. The aim of the present literature review was to evaluate the outcome of immediate implantation and provisionalization to replace single maxillary tooth at the esthetic zone.

Key words: immediate implantation, maxillary anterior, tapered implant

摘要

上顎前牙的植體贋復是牙科治療中具有挑戰性的術式之一。因為不僅要恢復病人咀嚼的功能，美觀部分也是一個重要考量。上顎前牙區的立即性的植牙方式，近期漸趨流行，因其有許多優點。相較於傳統植牙方式，它更能保留齒槽骨以及牙齦的豐隆度，使植體可以放置在更理想的位置，也因此其上的贋復物能製作得更完善與美觀。另外立即性的植牙方式縮短了整個治療的等待時間，病人心理上會有更高的接受度。本文將蒐集整理近期有關上顎前牙區單顆立即性植牙的研究論文，比較立即性植牙方式與傳統植體治療方式在成功率及植體周圍軟、硬組織表現等的差異，期待能對這個術式有更深入的了解。

關鍵詞：立即性植牙、上顎前牙、錐形植體

前言

上顎前牙採用植牙做贋復的治療方式的優點有：相較於傳統牙橋7~10年的壽命，植體有更長的存活率。此外，植體能持續讓牙嵴受外力刺激，減少骨頭因廢退而萎縮。單顆植體治療減少傳統牙橋的支柱牙容易因病人清潔不易而造成支柱牙的齲齒、牙周病等併發症，增加了支柱牙的存活率。傳統的植牙方式，會建議在拔牙後先等待2~3個月的時間，讓齒槽骨先做重新塑型後再植入植體。植入植體後，再等待3~6個月的時間讓植體在不受外力刺激的環境下骨整合，然後再接出上部贋復物完成治療。然而，拔完牙後，骨頭的吸收和軟組織的改變是很快速且持續的。研究顯示，骨頭的吸收，在拔完牙後的前半年，寬度會流失23%，前三年會有30%~40%齒槽骨的吸收。並且齒槽骨的吸收，在原本就較薄的唇側骨板會最明顯。在軟組織方面，因為前牙屬於美觀區，通常在等待接出最終贋復物之前，會幫病人製作臨時的活動假牙，而活動假牙可能會壓迫到牙齦組織，造成牙齦的萎縮。這些情形都會造成未來假牙贋復後美觀上的問題。因此近來趨向藉由拔牙後立即植牙的方式，縮短整個植牙療程及病人等待的時間，並期待得到更好治療結果。

立即性植牙

立即性植牙的定義即是在拔牙後的傷口內立即植入植體。這個觀念早在1976年 就由Schulte 與Heimke [1] 提出，不過直到1990代才開始被大家所重視。 立即性植牙的好處在於能保留骨頭，減少植牙手術的流程以及病人需要等待的治療時間。 而立即性植牙要成功，重要的還是在植體是否能有好的初期穩定。所以立即性植牙的適應症為：(1)植牙區有足夠並且密度高的骨頭 (2)植牙區的牙齒原本就保有好的牙齦外觀，並且植牙區的齒槽骨也都維持在正常高度，才有機會於植牙後有良好的美觀結果。立即性植牙的禁忌症是: (1)當拔牙的齒槽窩洞屬於在急性發炎期 (2)病患有磨牙異功能習慣或缺乏穩定的後牙咬合 (3) 唇側骨板因為拔牙或先前的發炎反應造成有較大範圍的骨缺損時，都不適合採用立即性植牙。[2]

上顎前牙的立即性植牙

對於上顎前牙立即性植牙的治療方式來說，會面臨到植體的大小、形狀和拔牙後齒槽窩洞不符合的問題。對於兩件式的植體，會要求植體跟臨近自然牙的距離至少都要有1.5mm，否則可能會造成牙間齒槽骨嵴的萎縮,影響齒間乳頭的高度而影響美觀，因為齒間乳頭的高度會受到牙齒和鄰牙接觸點到牙間齒槽骨嵴最高點的距離影響，一般認為兩相鄰的自然牙其接觸點到骨嵴最高點距離小於或等於5mm時，齒間楔隙才能完全被齒間乳頭所填滿。而在植牙上則可能條件更嚴苛，有學者建議相鄰的植牙與自然牙的接觸點到骨嵴的距離必須小於 4.5 mm，主要的原因是上顎前牙植體寬度大都小於5mm，並且植體的橫切面的形狀是圓形，然而例如上顎正中門牙CEJ以下2mm處齒槽骨高度的牙根橫切面寬度約5.5mm，且自然牙前牙橫切面通常都不是圓形而是呈三角或橢圓形的形狀。所以採用立即植牙的方式，勢必會有植體和齒槽窩洞外型不符的問題，植體寬度會比齒槽窩洞小，其間會有縫隙產生(Jumping gap)。

上顎前牙的立即性植牙成功率

Atieh 等人 [3] 在2009年以統合分析(meta-analysis)方法所做的文獻回顧，分析結論認為立即性植牙和植體植入癒合好的拔牙區之間的存活率是相當低或是稍低。但subgroup analysis結果則顯示，當立即性植牙的齒槽窩洞有補骨粉時，則兩者之存活率沒有顯著差異。而當立即性植牙的齒槽窩洞沒有放骨粉去補足縫隙時，得到的植體存活率就有顯著的差異。因此他們認為立即性植牙還是有較高的失敗率，所以建議還要在立即植牙之同時補骨粉，以促進植體周圍的骨整合速度，增加植體的初期穩定度來提升植牙的成功率。

立即性植牙之立即性贋復物的咬合

大部分上顎前牙立即性植牙的研究文獻顯示，其贋復物的咬合設計，大都採用調整到和對咬牙沒有合接觸的方式，即便是立即受力，也會調整到只有輕接觸。並且都會特別提醒病人，不要用植牙區咬較硬的食物。主要是因為這些學者們都希望能盡量減少植體因過度受力(overloading)而影響植體骨整合。尤其上顎前牙主要受力方式是不利於植體的側方力量。

然而，立即性植牙成功的關鍵跟立即受力植體一樣是希望植體有初期穩定度，

所以根據立即受力植體的觀念，當立即性植牙有好的初期穩定度，受力時植體的微振動(micromotion)能維持在安全範圍內，如Szmukler- Moncler等人[4]所提出的小於150μm。立即性植牙的立即受力不一定會影響到植體的預後，甚至可能有助於周圍骨頭的新生。不過確切的結果可能還是需要有更多臨床實驗來做支持。

臨床上為了增加立即性植體的初期穩定度，除了拔牙會藉由低創傷的方式，盡量保留完好的齒槽骨板，且會把植體置入至比原本拔除的牙齒根尖更深約3~5mm或至少2mm之處，並且會嵌入厚度比較厚的腭側骨板來增加植體的穩定度。

立即性植體周圍硬組織的臨床表現

在1990年代的學者，認為立即性植牙能夠幫助遏止拔完牙後周圍骨頭的吸收。然而後來的一些人體及動物觀察研究，都發現拔完牙後的立即植牙是無法阻止拔牙後的骨吸收的，且前牙在唇側骨板的吸收情形更為明顯，因而大大影響到植牙後的美觀。

形成這情況的可能原因，有的學者認為是因為唇側骨板本身就較薄，從組織胚胎學的觀點來看，骨板的主要成分都是bundle bone，所以容易隨著拔牙後，沒有了功能性刺激而流失掉。另外也有學者認為是因為拔牙後傷害了牙周韌帶，中斷了牙周韌帶的血液供應，近一步造成較薄的唇側骨板的吸收。不過目前對於拔牙後唇側骨板吸收原因，還沒有找到定論。[5]

在2010年 Ferrus[6]等人的研究，觀察93名病患上顎15~25的單顆立即植牙，追蹤16週後，發現立即性植牙周圍骨板的吸收似乎與骨板本身原本的厚度以及植體與齒槽窩洞之間的水平間距(jumping gap)大小有關係。 然而， Sanz 等人[7]進一步在90多名患者之前牙部位，分別隨機植入植體頸部不同寬度但植體末端相同寬度的柱狀和錐狀植體。觀察發現，不會因為採用不同設計植體，或改變植體跟齒槽窩洞之間的水平間距大小，而唇側骨板吸收程度有所改變。

目前比較有共識的，是當唇側骨板的厚度大於2mm時，較能預防骨板的垂直方向的吸收，然而 Huynh-Ba 等人[5]在2010年觀察93名病患，發現其中64%的人之上顎前牙的唇側骨板厚度只有0.5mm，將近90%的人厚度小於1mm，而要大於2mm厚度者的比例不到3%。

此外Lau等人[5,8]在2011年分析一百七十張華人的電腦斷層影像，發現上顎門牙的牙根80%都是貼著唇側骨板，並且80%的牙根長軸走向也都往唇側傾斜。同時發現，在上顎前牙牙根中段唇側的骨板厚度平均為0.9mm，牙根尖唇側骨厚度平均為2.04mm，最薄可能只有0.1mm，所以對大部分上顎前牙立即植牙的時候，唇側骨高度會再吸收是可預見的。

一些臨床研究認為補一些骨粉或做一些再生手術都多少能減少某程度骨量的吸收。Chen等人[9]在2007年對30位上顎美觀區單顆立即性植牙病患做觀察，研究齒槽窩洞和植體之間的縫隙有無補骨粉或做再生手術，會對周圍骨吸收造成什麼影響。他們發現有補骨和再生手術能減少唇側骨板水平方向的吸收，從原本大約會吸收50%，變成只吸收了25%，然而垂直方向的骨吸收則還是無法避免。為了代償拔完牙骨頭的吸收，他建議在拔完牙的齒槽骨板和植體之間的縫隙以及唇側骨板的唇側補骨粉或做骨再生手術，雖然研究顯示，不管採用哪種補骨材料或是不同的再生術式，都無法抵抗拔牙後骨頭的吸收，但至少都能讓骨流失的程度減少。

立即性植體周圍軟組織的臨床表現

Chen等人[9]在2007年的文獻，同時追蹤同一批病患3~4年，觀察牙肉組織的變化。他發現植體如果置入得太偏唇側，之後容易發生牙齦萎縮，而影響美觀。因此他建議立即性植牙時，植體的shoulder至少要離原本唇側骨板內側面2mm，將來比較不容易有美觀上的問題。這部分也有Buser等人[10]在2004年的報告，指出判斷的方式，他們建議從咬合面觀看，以植體左右鄰近牙齒的emergence point的連線當參考，植體不要種在超過這條連線往舌側1mm之間的位置，將來比較不會有美觀上問題。

此外，Chen等人[9]指出研究對象中，4位在拔牙當下就發現唇側骨板有骨缺損的病患，即使後來骨再生手術很成功，也補過牙齦，其中有3位病患後來還是發生牙齦萎縮的情形。所以他認為，如果預植牙區原本有一

些dehiscency，會提高未來牙齦萎縮的風險。

De Rouck 等人 [11] 在2008年針對上顎前牙單顆立即性植牙的文獻回顧文中提到，立即性植牙且立即贋復，在植體的存活率及齒間乳頭的高度較能得到可預期的結果，然而在唇側牙齦的高度則比較無法預期。主要是因為立即性的植牙無法阻止骨頭的吸收，而骨頭流失後，牙齦會跟著降下去。而在齒間乳頭的區域因為單顆植體臨近自然牙，可幫助保留牙間隙骨嵴，所以齒間乳突的高度比較不會如唇側牙齦高度一樣，容易受到明顯的影響。不過作者特別提到，回顧文獻中的實驗，採用測量軟組織的改變量都沒有標準化，例如有的文獻測量方式是採用臨近自然牙唇側牙齦緣最低點的連線當參考標準，以測量立即植牙的植體唇側牙齦緣和齒間乳突到參考標準的距離。然而這個參考基準有可能會因時間點的不同而有變異，因此可能會影響到測量數據的準確性，所以可能須要有更多採用標準化測量方式的文獻來做驗證。作者認為立即性植牙對於植體唇側結果比較無法預期，因此建議立即性植牙時，應考慮到治療後的美觀問題。比較適合使用在病人的牙齦，是屬於厚齒齦生物型或是牙齒外型比較接近方型者，當病患的牙齦是屬於薄齒齦生物型或牙齒的外型比較接近卵形或三角形者，則比較不適合採用立即性植牙方式，因為這種情形的病人比較容易因為牙齦稍微的改變，而產生較明顯的美觀上影響。

採用標準化方式觀察立即性植體軟硬組織的表現

Block等人 [12] 在2009年觀察76位在前牙區需要做單顆植牙的病患，隨機採用立即性植牙和拔牙後立即補骨做齒槽骨保存與等待四個月後再植牙的兩種治療方式（兩種方式皆在植完牙後立即接出臨時贋復物），比較不同治療方式對植體成功率、植體周圍軟硬組織的表現的影響，完成兩年追蹤記錄的患者共有55位。他們在記錄軟硬組織的改變時，都有特別設計標準化的方式來減少誤差。在記錄軟組織的改變上，有設計客製化的模板記錄拔牙前牙齒周圍牙齦的高度，而記錄硬組織的改變，一樣也使用特別客製化的模板。這個模板在舌側有擺放X光片的夾子，以確保X光片每次都能擺放在相同的位置，並搭配平行的X 光照射技術來減少實驗的誤差。兩年追蹤的結果發現，在植體成功率、臨接面齒槽骨高度、齒間乳突高度的改變上，兩個方式無顯著差異。但在唇側牙齦高度方面，兩年的觀察期則發現不同的術式結果是有顯著的差異。立即性植牙都會比拔牙補骨後等待四個月再植牙的方式，唇側牙齦萎縮的程度少1mm。因此立即性植牙方式，相對較有機會得到較好的美觀結果。

錐形植體之立即性植牙

採用錐形植體(tapered implant)進行立即性植牙時，一定會比使用標準柱狀植體得到更好的結果嗎？錐形植體或稱做牙根型植體(root-shaped implants)。使用在立即性植牙的理由主要是因為它的上部較寬，下部較狹窄的外型，跟牙根外型相似，術者希望藉由植體外型跟拔牙齒槽窩洞形狀類似的這個優點，減少植體和齒槽窩洞之間的縫隙，期望能達到更好的臨床結果。

Akkocaoglu等人 [13] 在2005年的研究顯示，立即性植牙時採用錐形植體，能有更好的植體穩定度。然而Lang等人 [14] 在2007年的臨床實驗結果，則認為立即性植牙時，採用錐形植體並不會得到更好的植體初期穩定度以及更高的植體成功率。並且Petrie與Williams [15] 在2005年，採用有限元素分析結果發現當採用錐形植體時，可能會增加齒間骨嵴的應變量，並且當植體較窄或較短時，這個應變量可能會增加高達1.65倍。因此，目前對於在立即性植牙時是否採用錐狀植體會得到更好的結果還沒有定論。

結論：

本文回顧的結果認為立即性植牙時，若事先審慎評估病人的條件，是有機會得到跟傳統植牙方式相當的治療成功率，並且能獲得減少病人的手術次數及治療時間的好處，甚至能有機會得到更好的美觀結果。以外，因為唇側骨板要大於2mm的比率是非常低且不常見的。因此為了代償拔完牙後唇側骨頭的吸收而影響美觀，目前的建議是前牙立即性植牙要合併骨粉填補或做骨再生手術。

References:

1. Schulte W, Heimke G. [The Tubinger immediate implant]. Quintessenz 1976; 27: 17 - 23.
2. Babbush CA. Dental Implants The Art and Science 2nd ed, 2011; Chapt 20: 313~4
3. Atieh MA, Payne AG, Duncan WJ, Cullinan MP. Immediate restoration/loading of immediately placed single implants: is it an effective bimodal approach? Clin Oral Implants Res 2009; 20: 645-59.
4. Szmukler-Moncler S, Salama H, Reingewirtz Y, Dubruille JH. Timing of loading and effect of micromotion on bone-dental implant interface: review of experimental literature. J Biomed Mater Res 1998; 43: 192-203.
5. Huynh-Ba G, Pjetursson BE, Sanz M, Cecchinato D, Ferrus J, Lindhe J, Lang NP. Analysis of the socket bone wall dimensions in the upper maxilla in relation to immediate implant placement. Clin Oral Implants Res 2010; 21: 37-42.
6. Ferrus J, Cecchinato D, Pjetursson EB, Lang NP, Sanz M, Lindhe J. Factors influencing ridge alterations following immediate implant placement into extraction sockets. Clin Oral Implants Res 2010; 21: 22-9.
7. Sanz M., Cecchinato D, Ferrus J, Pjetursson EB, Lang NP, Lindhe J., A prospective, randomized-controlled clinical trial to evaluate bone preservation using implants with different geometry placed into extraction sockets in the maxilla. Clin Oral Implants Res 2010; 21: 13-21.
8. Lau SL, Chow J, Li W, Chow LK. Classification of maxillary central incisors-implications for immediate implant in the esthetic zone. J Oral Maxillofac Surg 2011; 69: 142-53.
9. Chen ST, Darby IB, Reynolds EC. A prospective clinical study of non-submerged immediate implants: clinical outcomes and esthetic results. Clin Oral Implants Res 2007; 18: 552-62.
10. Buser D,. Martin W, Belser UC. Optimizing esthetics for implant restorations in the anterior maxilla: anatomic and surgical considerations. Int J Oral Maxillofac Implants 2004; 19 Suppl: 43-61.
11. De Rouck T, Collys K, Cosyn J. Single-tooth replacement in the anterior maxilla by means of immediate implantation and provisionalization: a review. Int J Oral Maxillofac Implants 2008; 23: 897-904.
12. Block MS, Mercante DE, Lirette D, Mohamed W, Ryser M, Castellon P. Prospective evaluation of immediate and delayed provisional single tooth restorations. J Oral Maxillofac Surg 2009; 67(11 Suppl): 89-107.
13. Akkocaoglu M, Uysal S, Tekdemir I, Akca K, Cehreli MC. Implant design and intraosseous stability of immediately placed implants: a human cadaver study. Clin Oral Implants Res 2005; 16(2): 202-9.
14. Lang NP, Tonetti MS, Suvan JE, Pierre Bernard J, Botticelli D, Fourmousis I, Hallund M, Jung R, Laurell L, Salvi GE, Shafer D, Weber HP. Immediate implant placement with transmucosal healing in areas of aesthetic priority. A multicentre randomized-controlled clinical trial I. Surgical outcomes. Clin Oral Implants Res 2007; 18: 188-96.
15. Petrie CS, Williams JL. Comparative evaluation of implant designs: influence of diameter, length, and taper on strains in the alveolar crest. A three-dimensional finite-element analysis. Clin Oral Implants Res 2005; 16: 486-94.

Topical Review

Marginal Bone Loss of Dental Implant: Biomechanical Difference between Dental Implant and Natural Tooth

植體周圍骨喪失之現象: 牙科植體與自然牙在生物機械性質上的差異

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There are several biomechanical variations existed between implant and natural tooth. Implant overloading may occur if clinicians do not take these differences into account. When, the overload was transferred to the implant and its surrounding bone peri-implant bone loss may be induced which leads to the failure of the implant therapy.
The first part of this article reviewed the biomechanical differences between implant and natural tooth, including the presence of the periodontal ligament, fulcrum and movement phases upon loading, micromotion and the responses to occlusal overloads. The second part will review the cause and the phenomenon of peri-implant bone loss. Clinicians should consider about "implant-protected occlusion" to reduce the harmful overload transmitted to the implant and its surrounding bone to make the implant prosthesis away from failure.

牙科植體（dental implant）與自然牙在生理與生物機械上的性質截然不同。植牙時若未對兩者的不同做適當考量，有可能會造成植體的過度負載（overloading），進而造成周圍支持骨的破壞而發生骨流失，而可能導致植體治療的失敗。

本文之第一部分討論生物機械性質上，自然牙與植體相異之處，包括了牙周韌帶的功能、自然牙與植體在移動模式上的差異、不同程度的微移動以及受到過度負載時兩者不同的反應。而第二部分則探討植體周圍骨喪失的現象，以及可能造成此現象的相關因子。最後，為了避免植體周圍骨之喪失超出正常範圍，本文提出應思考「保護植體式咬合」（implant-protected occlusion），以減小具傷害性的力量，達到保護植體的功效。

1. 就生物機械特性比較自然牙與植體相異之處

自然牙與牙科植體在生理與生物機械上的不同性質，可以下列項目討論：

1.1 自然牙周圍具牙周韌帶（periodontal ligaments）
1.2 移動模式（movement phases）
1.3 微移動（micromotion）
1.4 受到咬合過度負載時的反應（responses to occlusal overload

1.1 自然牙周圍具牙周韌帶（Periodontal Ligament）

牙周韌帶（簡稱PDL）是一富含血管和細胞之結締組織，此韌帶包圍著牙根，並位於牙根與牙周膜薄板（lamina dura）之間。牙周韌帶連接著牙骨質與齒槽壁（socket wall），故可將牙齒懸吊於齒槽內。其形狀為沙漏狀（hourglass），最窄的地位於牙根中段處，寬度約0.2~0.4mm，平均寬度為0.25mm[17]。

牙周韌帶組成 由牙周纖維（periodontal fiber）、細胞（cell component）及基質（ground substance）三大部分所組成。牙周纖維佔牙周韌帶的絕大部分，其纖維主要是由膠原蛋白所組成，依照走向可分為六大群，其中的斜向群（oblique group）佔了牙周纖維的三分之二，主要功能為緩衝咬合力量[17]。

牙周韌帶的功能 因其內含許多機械刺激感受器（mechanoreceptors），可感受到壓力或變形（distortion），並做出適當的反應。Schulte1在1995年提出牙周韌帶因具刺激感受器，可偵測早期的咬合力，並具有吸震功能（shock-absorbing），亦即類似避震器的效果，故可減少外力的衝擊效應以達到保護牙齒的目的。除此之外，牙周韌帶亦含本體感覺受器（proprioceptors），不僅可偵測到咬合力，也可以調控中心或離心運動之咬力（centric and excursive forces），對自然牙來說是個保護的機制。另一方面，由於牙周韌帶排列有固定方向，可使咬力沿著牙根由邊緣骨分散至根尖周圍骨。

再者，牙周韌帶可容許牙齒有些許的動搖度（mobility）。受力時，自然牙便可以藉由其動搖來吸收咬力，以減少牙齒及周圍骨的變形。

1.2 移動模式（movement phases）

牙周韌帶具有可壓縮變形的特性，造成植體和自然牙適應咬合力的差異相當大。自然牙受力後會有兩階段的移動，如Fig.1，初期為有牙周韌帶存在而產生非線性且較為複雜的移動模式，後期則是藉由周圍骨之變形產生線性且有彈性的移動模式[2]。相反的，當植體受力時僅出現一種移動模式，亦即線性且具彈性的漸進移動模式，此移動範圍是由植體周圍骨之彈性所提供[3]。

1.3 微運動（micromotion）

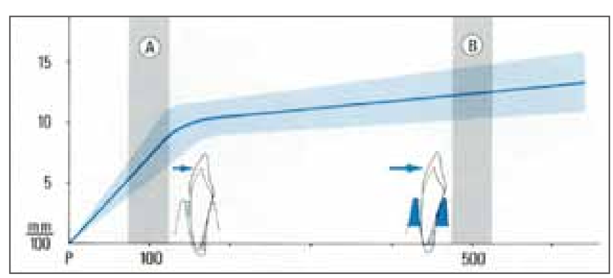
根據Parfitt[4]（1960）、Sekine 等人[3]（1986）、Schulte1（1995）等的研究，得知自然牙受力後垂直向的微運動範圍可從25 μm到100 μm，相對的，植體卻只有3-5 μm；而側向的微運動，自然牙主要是頰舌向的移動，約56至108 μm，但植體只有10-50 μm。兩者在微移動程度上的差距，造成緩衝受力的能力不同，植體因微移動範圍小，相對自然牙來說，較易直接接受咬力衝擊。

1.4 受到咬合過度負載時的反應（responses to occlusal overload）

對於自然牙而言，因為具牙周韌帶可緩衝咬力，但若承受過大咬力，仍可能會造成自然牙的破壞。例如牙周韌帶的吸收、牙周韌帶的空間增寬、牙齒動搖度的增加等現象，在牙齒本身則可能造成牙面磨耗、斷折及疼痛等現象。另一方面，植體若受到過大咬力，對於其上之贋復物可能會發生斷裂、黏著劑破壞而失效等問題；對於支柱螺絲(abutment screw)而言，最常見的是發生螺絲鬆動，甚至斷裂的問題；對植體本身來說則可能發生植體斷裂，或植體鬆脫等現象。最後，對周圍組織來說，很有可能會發生周圍骨的持續喪失，最終造成植體治療的失敗[5]。

2. 植體周圍骨喪失 （peri-implant marginal bone loss）

即使現今植體治療已有九成五以上之成功率，在植體周圍仍會觀察到植體周圍骨喪失之現象。少量的植體周圍骨喪失被視為是正常的現象，但持續之骨喪失將視為失敗治療。骨喪失使植體周圍形成一圈淺碟狀（saucerization）之骨缺陷，通常會使周圍骨之水平面往根尖方向流失至植體第一螺紋處[6]。



Herbert F. Wolf. Color Atlas of Dental Medicine: Periodontology, 1985

有關植體周圍骨喪失現象本文有以下之討論：

2.1 植體周圍骨喪失之原因
2.2 植體周圍骨喪失之量
2.3 植體成功率與骨喪失量之關聯
2.4 骨喪失量與骨密度之關聯

2.1 植體周圍骨喪失之原因

造成植體周圍骨喪失之原因的討論，可歸納出以下幾種：7

1) Adel等人l8於1981年提出，植體在接出支柱體後的第一年可能因受力不當而造成骨喪失
2) 手術中造成創傷（surgical trauma ）
3) 旋轉而置入植體時，施予過大扭力或壓力
4) Cochran9於1997年提出，植體為了適應環境而發展出自身生物性寬度（biologic width），而有些許骨喪失現象
5) 植體表面性質之不同（implant surface characteristics）
6) 植體頸部之平滑處與骨接觸，將會造成骨喪失
7) 細菌侵害（bacterial invasion）

文獻上，植體不當負載（loading）與骨喪失相關的討論最多，尤其是在骨塑形活動頻繁的第一年期間，若受到了過度負載（overloading），將造成周圍骨組織的微傷害（micro-injury），不僅可能造成骨喪失，也可能造成骨整合的失敗。

2.2 植體周圍骨喪失之量

Goodacre 等人10在1999年的回顧裹整理了13篇文獻，針對幾種不同植體支持的贋復物來觀察植體成功率與併發症之相關性，其中包括植體支持之全口義齒、覆蓋性義齒以及植體支持之固定假牙，追蹤期為0.3年至4年。統計後得知植體植入後第一年之骨喪失量由最少0.4mm至最多1.6mm，平均骨喪失量是0.93 mm；而植入第二年之後，每年骨喪失量約為0至0.2mm，平均骨喪失量為每年多0.1mm。(Fig.2) Jung 等人11觀察Steri-Oss與 3I植體系統共62支植體之骨喪失量，由根尖X光片量測的結果為，牙科植體在開始使用後的第一年會有1.3 至2 mm的骨喪失量。

此外，Goodacre 等人10回顧中包括三篇文獻，指出在一至三年的觀察期間有植體邊緣骨喪失之病人，大多數人邊緣骨喪失量在0.5至1mm之間，而很少數的病患其骨喪失量多於2mm；相反的，亦有許多病患在觀察期間骨水平無改變，甚至有一部分的人有骨增加（bone gain）的現象。(Fig.3)

Table XXI. Bone loss over time

	Type of prosthesis	Length of study(y)	Mean loss in 1st year(mm)	Subsequent loss per year(mm)
Adell et al[1]	IFCD	1-15	1.2	0.1
Adell et al[78]	IFCD	3	0.9	0.05
Cox and Zarb[2]	IFCD	1-3	1.6	0.1
Quirynen et al[79]	IFCD	6	0.8	0.1
Naert et al[11]	IOD	0.3-4	0.75	0
Johns et al[46*]	IOD	1	0.4	N/A
Quirynen et al[80*]	IOD	4	1.0[+] 3.2‡	0.05-0.1[+] N/A‡
Gunne et al[32]	IFPD	2	0.4	0.1
Pylant et al[22]	IFPD	2	1.5	0.1
Jemt and Lekholm[25]	IFPD	5	0.4	0.1
Lekholm et al[30]	IFPD	5	0.4	0.12
Laney et al[39*]	ISC	3	N/A	0.1
Andersson[41]	ISC	2-3	1.3	0.2
Mean of all studies			0.93	0.1

Goodacre et al. The Journal of Prosthetic Dentistry, Volume 81, Issue 5, May 1999, Pages

2.3 植體成功率與骨喪失量

在植體治療中，少量的植體周圍骨喪失被視為是正常的現象。Smith與Zarb12在1989年提出了植牙成功率的標準，其中一項便是植體在使用第一年之後，每年骨流失量應小於0.2mm，而此標準仍沿用至今。Quirynen 等人13於1992年提出，若邊緣骨喪失持續進行，便視為植體治療中的併發症。Spiekermann 等人14於1995年觀察136組植體固位覆蓋性義齒，共600支植體之存活率，認為若骨喪失量大於4mm，則此植體便算失敗。

2.4 骨喪失量與骨密度

骨喪失量亦與承受植體之骨之密度有相關。Manz（1997）15在給予假牙後的六個月間，觀察骨之喪失量，發現第一型骨質骨喪失量最少，為0.68mm，而第二、三、四型骨

Table XXII. Change in marginal bone level over time

	Study length(y)	%Patients with marginal bone change					
		Bone loss				No change	Bone gain
		>2mm	1-2mm	0.6-1.0mm	0.1-0.5mm	0mm	>0mm
Van Steenberghe et al[53*]	0-1	2.0	9.5	20.0	26.5	27.0	15.0
Henry et al[54*]	1-3	0.4	4.4	10.4	25.0	25.8	34.0
Quirynen et al,[80] FCD(mandible)	0-1	0.5	5.8	41.5	29.9	20.5	1.8
	1-2	1.5	2.1	5.0	23.4	55.3	12.7
	2-3	0	2.0	5.9	25.5	49.0	17.6
Quirynen et al,[80] FCD(maxilla)	0-1	4.5	20.1	23.5	24.0	22.3	5.6
	1-2	0	3.9	6.8	25.7	37.1	26.5
	2-3[+]	3.4	13.7	5.2	6.9	31.0	37.8

質則分別為 1.10mm、1.24mm及1.44mm。依實驗結果推論，骨組織越緻密者，其植體周圍骨之喪失越少。

為了避免植體周圍骨喪失持續進行，我們應適度調控植體的受力，以避免過度負載。Misch 與 Bidez (1994)[16] 發展出「保護植體式咬合」（implant-protected occlusion）的觀念，即減小植體接受具傷害性力量的機會，以達到保護植體的功效，例如增加植體數目、使用寬且長之植體，以增加作用面積，或是減小咬頭高度、縮小咬合面寬度等，皆可減少植體受到過多側力，而增加軸向負荷的比例；再者，避免過長的懸臂式假牙，或是留意病患有無異功能，如此能避免植體受到過大的咬合負荷而造成失敗。

結論

本文探討自然牙與牙科植體在生物機械上的不同之處。自然牙藉由牙周韌帶維持與齒槽骨的關係；而經過骨整合（osseointegration）的植體則是直接附著於周圍骨上，並無牙周韌帶存在於植體周圍。故植體適應咬力或是感受機械刺激的能力也都大幅下降，這樣的結果易導致植體過度負載（overloading），而過度負載也被認為與植體周圍骨喪失（crestal bone loss）有極大的相關。些許的植體周圍骨喪失是正常的，而第一年之後每年之骨喪失量小於0.2mm，才可稱為成功的植體治療。如果骨喪失的現象持續進行，則為一種病態現象，可視為植體的併發症。為了避免植體周圍骨喪失持續進行，我們應對植體的負載有適度的調控，以避免過度負載。減小過度負載的方法，可由增加骨與植體之接觸面積、改變咬力方向為軸向負荷、減小過大咬力等方法實施。最後，每年的追蹤檢查更是重要的一環，密切的觀察與適度的調整能避免更多併發症的產生。

參考文獻

1. Schulte, W. Implants and the periodontium. Intl Dent J 1995; 45: 16–26.
2. Rateitschak KH, Rateitschak EM, Wolf H F. Color Atlas of Dental Medicine: Periodontology 1st ed. , Thieme Medical Publishers. 1985, p8
3. Sekine H, Komiyama Y, Hotta H, Yoshida K. Mobility characteristics and tactile sensitivity of ossointegrated fixture-supporting systems. In: van Steenberghe, D, eds. Tissue integration in oral maxillofacial reconstruction. Amsterdam: Excerpta Medica 1986; pp326–32.
4. Parfitt, G.J. Measurement of physiological mobility of individual teeth in an axial direction. J Dent Res 1960; 39: 608–18.
5. Misch C. Contemporary Implant Dentistry 3rd ed. , Mosby Co, 2008 ,pp72-88,
6. Schwarz MS. Mechanical complications of dental implants. Clin Oral Implants Res 2000; 11 (Suppl.): 156–8.
7. Kim Y, Oh TJ, Misch CE, Wang HL. Occlusal considerations in implant therapy: clinical guidelines with biomechanical rationale. Clin Oral Implants Res 2005;16: 26-35.
8. Adell R, Lekholm U, Rockler B, Brånemark PI. A 15-year study of osseointegrated implants in the treatment of the edentulous jaw. Intl J Oral Surg 1981;10:387–416.
9. Cochran DL. A comparison of endosseous dental implant surfaces. J Periodontology 1999; 70: 1523–39.
10. Goodacre CJ, Kan JY, Rungcharassaeng K. Clinical complications of osseointegrated implants. J Prosthet Dent. 1999;81:537–52.
11. Jung YC, Han CH, Lee KW. A 1-year radiographic evaluation of marginal bone around dental implants. Intl J Oral Maxillofac Implants. 1996; 11: 811–8.
12. Smith DE, Zarb GA. Criteria for success of osseointegrated endosseous implants. J Prosthet Dent 1989; 62:567-72.
13. Quirynen M, Naert I, van Steenberghe D. Fixture design and overload influence marginal bone loss and fixture success in the Brånemark system. Clin Oral Implants Res 1992; 3:104–11.
14. Spiekermann H, Jansen VK, Richter EJ. A 10-year follow-up study of IMZ and TPS implants in the edentulous mandible using bar-retained overdentures. Int J Oral Maxillofac Implants. 1995;10:231-43.
15. Manz MC. Radiographic assessment of peri-implant vertical bone loss: DICRG Interim Report No. 9. J Oral Maxillofac Surg. 1997;55 (Suppl 5):62-71.
16. Misch CE, Bidez MW. Implant-protected occlusion: a biomechanical rationale. Compendium 1994;15: 1330–44.
17. Lindhe J, Karring T, Lang N. Clinical Periodontology and Implant Dentistry 4th ed, Wiley-Blackwell, 2003. pp27-30

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1000-1050	李明澍醫師	**人工植體生物力學-從理論到實證** 子題二：植體與補綴物介面的考量	
1050-1110 Coffee break			
1110-1150	林立德醫師	**人工植體生物力學-從理論到實證** 子題三：生物力學於臨床治療的應用	
1150-1210	聯合討論		
1210-1340 Lunch break			
1340-1420	許明倫醫師	Bone biomechanics of implant dentistry.	陳玫秀 醫師 (北醫場) 張瑞忠 醫師 (奇美場)
1420-1520	許綺真醫師	Clinical Application of Provisional Restorations in Anterior Implant Prosthodontics	
1520-1540 Tea break			
1540-1640	林嘉澍醫師	當植體成為痛苦根源:有關植牙引發之疼痛與感覺異常的理論與實務	

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@ 不需認證登錄者報名時得免填身分證字號。

@ 籲請尊重講員智慧著作權，出席課程時請勿私自作任何影像或聲音記錄之行為。

@ 本次活動不克提供講員演講內容講義，敬請見諒。

2. 逾期報名者為免通知不及，請改現場報名，收費為5000元

» 附註：

1. 需繼續教育積分點數證明書者加收100元。
2. 會期間敬備茶點、午餐，午餐如需食素，請詳註於劃撥單中以便預備。
3. 以上課程費用經繳費後，未能到場時歉難退費或換場次，敬請見諒。
4. 請以劃撥方式報名，並請詳註需繼續教育積分點數證明書與否等…。
5. 本會郵局劃撥帳號13195250戶名：中華民國贋復牙科學會。