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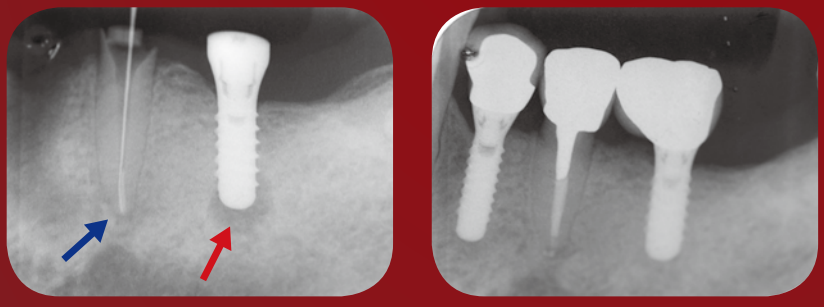

Retrograde Peri-Implantitis: A Case Report Page 4 fig. 2 and fig. 6

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TABLE OF CONTENTS

Journal of Prosthodontics and Implantology

Editorial

Will this journal terminate soon?

This issue is published in May, and is 3 months behind schedule. It seems the intention to submit research papers to this journal has been weak since this journal was established two years ago. In recent years, scholars do basic or clinical research like to submit their works to a so called SCI journal which is generally recognized having higher academic contribution. It is understandable for authors not to submit papers to a non-SCI journal because the same effort of paper writing can be more credential if it is published in a SCI journal. Moreover, in recent years, evaluation of research activity is not based on how many papers are published, but on how many papers are published in SCI journals. Therefore, with limited time and research resources, researchers may often refrain from submitting their research outcomes to a non-SCI journal. For young journals like this journal, would be less attractive to writers who are looking for promotion in institutions or better credit for research fund searching. Thus the quantity and quality of articles presented in non-SCI journals will not be sufficient to become a SCI journal. Therefore, a non-SCI journal will remain non-SCI, and the consensus of manuscripts submission remains low. The vicious cycle does not seem easy to break.

As the chief editor of this journal, I would suggest our academy's specialist enrollment committee increase the weight of papers published in this journal. Continuous paper publication in this journal should be one of the criteria for maintaining the specialist title. In addition, specialist training centers should encourage their prosthodontists to submit papers to this journal at least one paper each year to maintain its training center status for annual re-evaluation. By doing so, the consensus of paper submission to this journal would be raised, and the quality of this journal can be improved in no time.

Nevertheless, in this issue, we are pleased to include a review article written by Professor Hom-Lay Wang and his team in the University of Michigan, USA. This article covered many important topics and research outcomes related to dental implantology. Their efforts provided readers a simple and thorough way to consider when they are dealing with their implant patients.

Yuh-Yuan Shiau, DDS, MS. FICD
Editor in Chief

Review Article

Relationship Between Periodontics and Prosthodontics: The Two-Way Street

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Abstract

The interdisciplinary approach has been a trend for a comprehensive dental treatment. Within modern dentistry, periodontics and prosthodontics share an intimate and inseparable relationship in multiple aspects, including treatment plan, procedures execution, outcome achievement and maintenance. By controlling inflammation and preparing sites for proper prosthetic prostheses, periodontists no doubt can provide a solid foundation for successful prosthetic outcomes. On the other hand, prosthodontists could construct proper restorative margin, shapes and contacts that benefit the harmony of periodontium and prosthesis. This article was aimed at addressing the key relationship between prosthodontics and periodontics. The impacts of healthy periodontium on longevity of prostheses were addressed. In addition, how the restorative factors such as biologic width violation, retraction techniques and defective restorations, influenced on periodontal/ peri-implant tissues were also discussed. This systematic review also comprised the association between the presence of residual cement and the occurrences of peri-implant diseases. In short, frequent and efficient communications are essential between periodontists and prosthodontists through the entire treatment procedures to ensure an overall successful treatment since both specialties share a common goal: to create pleasing esthetic with a harmonious stomatognathic system.

Keywords: Periodontics, restorative, prosthodontics, implant, biologic width, inflammation

Introduction

Comprehensive dental therapy is founded on team works. Of all disciplines within modern dentistry, periodontics and prosthodontics have the strongest and the most intimate connections. For prosthodontics, periodontal health plays an important role on the longevity of restorations. On the other hand, defective prostheses may contribute to progression of periodontal diseases. To achieve successful treatment outcomes, periodontists and prosthodontist should cooperate in treatment plan, per-

formance and maintenance.

This review attempted to address the key relationship between periodontics and prosthodontics. The interaction between periodontal health and prosthetic factors were discussed as well as the recent hot issues related to dental implants.

The impacts of periodontal/implant health on prosthetic therapy

Prior to treatment plan, tooth prognosis should be addressed both on individual tooth and the overall dentition. Several periodontal prognositication systems have been introduced based on either periodontal stability[1] or certain parameters[2-4], such as furcation involvement, tooth mobility, the severity of bony destruction, etc. Through identifying the etiology and contributing factors of periodontal diseases, these prognositication systems indicate the possibility of tooth sustainability in short term and long term. As an integral portion of dental practice, determination of individual teeth prognosis allows a virtual approach on interdisciplinary conversation for treatment strategies. Overall prognosis is beneficial to communications between lay people and professionals.

Active periodontal/peri-implant diseases and contributing factors should be eliminated or controlled prior to prosthodontic constructions. The signs of active periodontal inflammation include pocket formation, the presence of bleeding on probing or suppuration, and tissue changes of gingiva. Without controlling the existing periodontal inflammation, a cascade of adverse events of periodontal destruction would take place and cause persistent inflammation, bone resorption and eventually tooth loss. In other words, function and lifespan of the prosthesis will be compromised if periodontal diseases remain uncontrolled after delivery. In addition, periodontal inflammation results in soft tissue changes in terms of texture, color, size and gingival consistency. It then leads to impaired esthetic outcomes by deteriorating the harmony between periodontium and prosthesis.

In addition to inflammation control, periodontists could offer a hand for soft and hard tissue management to prepare sites for successful prosthetic treatments. Surgical procedures, such as ridge and bone augmentation as well as sinus lifting, could be performed for future implant sites to correct existing ridge deformities. Although the effects of mucogingival defects on periodontal/peri-implant inflammation remained inconclusive[5-7], mucogingival procedures may also benefit esthetic outcomes and oral health maintenance.

Regular periodontal maintenance is a key to reduce the incidence of tooth or implant loss following prosthetic therapy. Due to limitation of routine home cares, regular professional maintenance therapy plays a key role on reduction of periodontal inflammation induced by plaque accumulation, especially in the subgingival space. For those patients who had history of periodontitis, regular supportive periodontal therapy is even more beneficial to prevent further disease progression. Previous studies showed that sites with treatment but without maintenance had a 2 times higher tooth loss than the sites with regular maintenance after periodontal treatment[2,3]. A recent study even showed a 3 time higher tooth loss in the irregular compliers comparing with patients with regular maintenance over a 5-year observation period. Besides, the results also showed that the majority of these teeth were missing due to periodontal origins. In other words, regular compliance of periodontal maintenance is the key to prevent the recurrence of periodontal diseases and to maintain the integrity of treatment outcomes[8].

The impacts of prosthetic factors on periodontal/ peri-implant health

Prostheses should be carefully designed and performed, in harmony with the surrounding periodontium, to maintain periodontal/ peri-implant health. Defective restorations contribute to disease progression by increasing accumulation of dental plaque and retention of food debris. Invasion of biologic width may also result in periodontal inflammation.

Biologic width

The dimension of dentogingival complex, called "biologic width (BW)", is a cuff-like barrier that acts as a protective physiological seal around natural teeth. It possesses a self-restoration capacity and dynamic adaptability. The compositions of BW include junctional epithelium and connective tissue attachment. The mean distance of epithelial and connective tissue components are 0.97mm and 1.07mm, respectively. However, the dimension is dynamic in particular the epithelial attachment, varying from individuals[9]. Similar to natural teeth, a consistent width of peri-implant mucosa was found adhering to the surface of the

implant abutment. Histologically, it prevents further supragingival plaque formation via a zone of healthy connective tissue separating the inflammatory cell infiltration and alveolar bone crest[10,11].

The violation of BW has been widely discussed as a contributing factor which jeopardizes periodontal health[12,13]. BW invading could result from several reasons, such as extensive caries, subgingival restorations, short clinical crown, and teeth fracture. From human autopsies, Vacek and coworkers reported greater length of epithelial attachments around restored teeth than non-restored teeth[14]. In the group with supracrestal amalgam restorations, BW violation would also lead to significant increases of gingival recession and crestal bone loss[12]. Resulting from the breach of BW, histologically, attachment loss will be found to reestablish the certain dentogingival junction around restorations and lead to periodontal destruction. Clinically, the signs of BW violation consist of pain, gingival inflammation, localized gingival hyperplasia, pocket formation, and loss of periodontal apparatus. Therefore, further corrective procedures should be considered prior to restorative treatments if any qualms about BW violation, including orthodontic extrusion and surgical crown lengthening procedures.

Surgical crown lengthening could be performed via multiple techniques: gingivectomy, apically positioned flap surgery (APF), APF with osseous reduction. From periodontal point of views, several parameters should be taken into account for the feasibility of this surgery: esthetics, possible exposure of furcation involvement, remaining bony support and crown/ root ratio for the future results. In spite of individual and sites variations[15], a minimum of 3mm distance from bone to the restorative margin has been suggested by most researches[13,16]. The ferrule effect for the future prosthetic design should also be a key factor in determination of the surgical plan[17,18]. Postoperatively, final prostheses should only be delivered once the tissue maturation was completed. A minimum of 6-8 weeks of healing period is highly recommended following surgical crown lengthening that without bone resection. From a total of 85 teeth of 25 patients, Bragger and coworkers found that 12% of teeth sites showed further apically marginal displacement between 6 weeks to 6 months postoperatively[16]. As a result, 6 months of waiting period should be taken in those sites with high esthetic demands or sites with bone removal[19]. Hence, communication prior to treatments between periodontists and prosthodontists is essential to determine the treatment timeframe, feasibility of surgery and the locations of restorative margins.

Most researchers believe that BW is one of the causes of early implant bone loss[20,21]. During the initial phase of implant healing, peri-implant bone remodeling is from the process of BW reformation to allow a stable soft tissue barrier[22]. In addition, the locations of microgaps and smooth/rough-surface interfaces may be associated with the length of peri-implant BW[23,24]. Thus, one of the strategies to prevent early implant bone resorption is control of biologic width and microgap. In 2006, Lazzara and Porter introduced the concept of "platform-switching" for inward horizontal repositioning of the implant-abutment junction[25]. Via connecting the implant fixture with a narrow-diameter abutment, the inflammatory cell infiltration could be limited around the implant neck with platform-switching design, instead of further apical migration. Previous studies suggested that platform-switching may benefit tissue preservation. On the other hand, limited effects of platform-switching on hard tissues have been claimed by some authors[26-31]. The clinical significances of effects on marginal bone preservation may be questioned. In conclusion, the available data remained controversial and further longitudinal studies are still needed.

Proximal relationship

Embrasure types, referring both horizontal and vertical dimensions of the interproximal spaces, show impacts on the presence of interproximal papilla. Loss of interproximal papilla results in impaired esthetics and promotion of food impaction, aggravating periodontal destruction. As for the distance from contact point to the alveolar crest, the maximum of the distance should not exceed more than 5mm to preserve the interdental papillae in natural dentition[32]. This concept has also been confirmed by a retrospective study examining the vertical dimension between single implant restorations and a natural tooth[33]. The demands for implant-support prosthesis are more strict: a minimum of 3mm of inter-implant distance is suggested to maintain the alveolar crestal level, preventing the possible papillary loss; whereas papillary loss would be expected if the verti-

cal dimensions between two implants is more than 3mm[34,35].

Contact types between prostheses may also play a role on periodontal health. The relationship between open contacts and periodontal destruction has been a controversial issue since last century. To verify the impacts of open contacts on periodontium, Jenberg and colleagues conducted a cross-sectional study enrolling 104 patients with unilateral open contacts. In addition to greater prevalence of food impaction, the sites with open contacts presented greater pocket depth and clinical attachment loss although there was no significant difference for gingival index, bleeding and calculus index between contact types[36]. Moreover, another cross-sectional study reported an increase of bone loss (2.4%) in the patients with initiate periodontitis[37]. However, another classic study failed to approve the trend from a total of 1040 contacts. On the other hand, the authors suggested the increasing pocket depth may be in relation to the presence of food impaction[38]. In spite of an indirect relationship between open contact and periodontal inflammation, it could be speculated from these studies that food impaction contributes to increasing pocket depth and clinical attachment level. Thus, clinicians should avoid to place open contacts between fixed prostheses. Meanwhile, through proximal cleaning should be addressed to patients.

Restoration contours

Adequate crown contours could provide protection of gingival margins, allow cleansing action of the musculature and facilitate the access for oral hygiene[39]. Indeed, overcontour may have negative influence on periodontium since it increases plaque retention[40,41]. Utilizing acrylic facings as standard overcontour, Sackett and Gildenhuys compared tissue changes at 42 pairs of experimental and control sites (adjacent teeth) over a period of 42-49 days. 59% of mandibular test sites and 70% of maxillary test sites showed significant gingival inflammation in relation to overcontour. Besides, more than 50% of these sites had increasing amount of gingival sulcular fluid compared with their controls[42].

Restorative overhang is also considered as a contributing factor of periodontal diseases. As a prevalent type of restorative defects[43], filling excess may aggregate the plaque accumulation which potentiates gingival inflammation and worsen the periodontal status[44,45]. Evaluating 100 patients, Jeffcoat and Howell classified overhang into 3 sizes: small (<20% of the interproximal space), medium (20-50%) and large (>50%). A significant marginal bone loss affiliated to the restoration occupied more than 20% of interdental space[46]. Vice versa, removal of overhang may also benefit the reduction of pocket depth and clinical attachment gain[47].

To sum up, restorative overhang should be prevented by the proper uses of matrix bands and wedges. Meanwhile, inadequate crown reduction for the restorative material should be avoided to prohibit the overcontoured crown.

The location of restorative margins

Restorative margin locations should be established based on several factors, including extension of caries, retention/resistance forms, and esthetics. Using free gingival margin as the references, the supra- and subgingival restorations have their own pros and cons. With respect to periodontal health, the supragingival restoration is the most favorable design since it is easy to be cleaned[48]. In spite of better esthetics, subgingival restorations were associated with greater periodontal inflammation in the sites with keratinized gingiva less than 2mm[49]. In addition to tissue biotype, subgingival restorative margins may be harmful to periodontium/ peri-implant tissues because of the following reasons. First, the margin has higher risk of BW invasion, enhancing further periodontal destruction. From 59 patients, Newcomb investigated a total of 75 anterior veneer crowns with subgingival margins. A strong positive correlation was found between gingival inflammation and the subgingival extension of restorative margins[50]. The limited access is another possible cause when restorative margins are placed subgingivally. In particular amalgam or composite resin fillings, it is difficult for operative dentists to polish restorations and thereby produce rough surfaces underneath gingiva. Rough surfaces are more prone to accumulate dental plaque and, therefore, induce periodontal inflammation[51]. Likewise, overhang and improper restorative margins could be ascribed to the progression of periodontal destruction due to the inclination of plaque accumulation[43]. Even though subgingival cementation margin is a common procedure on the implant in esthetic zone, moreover, it is difficult to discover the excess cement residuals around subgingivally placed implants. Investigating the amounts of undetected cement following cleaning, Linkevicius and coworkers

found significantly greater cement remnants were linked to deeper subgingival margin positions. The lack of perpendicular fiber attachment around dental implants may even facilitate the apical migration of cement excess and worsen the tissue inflammation[52]. Furthermore, the efficacy of proper oral hygiene maintenances is questioned for extensively subgingival restorations. The penetration depths of plaque control methods for homecare is within 1-3mm subgingivally, such as mouth rinsing[53], toothbrush[54,55], and interproximal cleaning[56]. In regards to subgingival irrigation, American Academy of Periodonotology (AAP) positioned paper suggested a 3mm of subgingival penetration or 50% of the probing depth[57].

To prevent periodontal destruction, in conclusion, supragingival restorative margins are highly recommended at the sites with less esthetic concerns. For the site that the subgingival margin is required, certain principles should be bear in mind including conservatively subgingival extension of restorative margin, sufficient width of keratinized gingiva (at least 2mm of keratinized gingiva including 1mm of attached gingiva), smooth restorative surfaces with proper finished margin and the avoidance of BW breach. Adequate daily home care needs to be addressed to patients and regular professional maintenance is necessary.

Trauma from occlusion

As a functional unit, the tooth and its supporting structures bear the brunt of occlusal forces on the crown. In response to occlusal forces, the attachment apparatus may experience tissue changes, including injury, repair and adaptive remodeling of the periodontium. Several factors are relative to trauma from occlusion (TFO) including occlusal disharmony, parafunction (i.e. clenching and bruxism), and occlusal schemes. Although the role of TFO plays in periodontal/ peri-implant diseases remains controversial, clinicians should perform prosthetic treatments with caution to avoid failure following TFO.

As a result of excessive force or reduced periodontal supports, teeth under TFO or occlusal trauma showed following clinical characteristics: tooth pain, increasing tooth mobility, sensitivity to percussion, fremitus, occlusal wear and even tooth fracture. The radiographic changes consist of PDL space widening, disruption of the lamina dura, root resorption and peri-apical or furcation radiolucency[58]. Some researchers believe it may aggravate the existing periodontal destruction as a co-destructive factor along with inflammation[59,60]. Previous studies also demonstrated a significant role of tooth mobility on progression of periodontal diseases[61,62]. A cross-sectional study examined the signs of TFO and severity of periodontitis from 333 maxillary first molars of 300 patients. In comparison with teeth without TFO, the group with TFO had significantly greater probing depth, greater clinical attachment loss and less bone support[63]. In the late stage, chronic TFO may cause tooth migration and loss of vertical dimension, enhancing impaired esthetics and the need of oral rehabilitation[64,65].

Occlusal overloading also causes biomechanical implant complications and marginal bone loss around dental implants[66,67]. By creating supra-occlusion, Miyata and coworkers investigated the effect of occlusal overload on peri-implant tissue in a series of studies. It showed that the excess occlusal force could initiate marginal bone resorption even under the circumstance of healthy peri-implant tissue. In addition, the disease may not be reversed once it progressed[68,69]. With the persistence of excessive force, loss of osseointegration is possible and end up with implant failure[70]. Other clinical manifestations of biomechanical implant complications include fracture of prosthetic components and loosening of attachment or abutment screw[71,72]. In addition to implant overloading, several factors may contribute to biomechanical implant complications, including bone quality[73], implant designs[74,75], prosthetic design[76,77] and parafunction[78,79]. To deal with mechanical complications, check occlusion is the first step to verify the etiologic factors. All possible contributing factors should also be controlled or eliminated before repair or replacement of loosening/ fractured components. Non-surgical or surgical intervention may be considered in the treatment of marginal bone loss. Ultimately, the patient is highly recommended to wear the occlusal splint to prevent the recurrence of biomechanical complications[67].

Gingiva retraction technique: the effects on soft tissue

An acceptable impression was needed to avoid improper marginal adaptation that may cause periodontal tissue inflammation or the risk of recurrent caries. Management of the gingival tissue is essential for obtaining acceptable impression especially for subgingivally located restorations[80]. Various gingival displace-

ment methods, such as mechanical, chemo-mechanical and surgical are available. Ruel and coworkers reported that gingival displacement methods may cause 0.1-0.2 mm gingival recession and the destruction of the junctional epithelium that took 8 days to heal[81]. Chemical agents as well as the mechanical force of retraction cords could trigger temporary gingival recession and gingival inflammation[82,83]. It has been shown that the different time intervals of the chemical retraction agent placement could cause different degree of tissue inflammation changes in the beginning[84]. Hence, the proper manipulation different gingival retraction techniques such as materials and time-control are the key factors to avoid permanent tissue damage while impression-taking process is made.

Recently, cordless techniques have been introduced as an alternative to displacement cord methods because of several advantages, such as time-saving, ease of application, less pressure generation and enhanced patient comfort while being minimally invasive[85,86]. Acar and colleagues evaluated the clinical performance and impression quality on the cordless and conventional displacement systems. The results demonstrated that all methods can give the comparable and clinically acceptable impression qualities except for the nonimpregnated cord group[87]. Furthermore, a randomized clinical trial was conducted to assess the clinical and immunological factors related to conventional and cordless techniques. The results demonstrated the cordless method was less stress for patients and resulted in lower post-treatment levels of inflammatory cytokines[88].

Current hot issue

Peri-implant diseases are multi-factor diseases with signs of peri-implant tissue inflammation[89]. Residual excessive cement around cement-retained implant-supported restorations is related to peri-implant complications[90,91]. To investigate the association between residual cement and peri-implant diseases, Wilson used a dental endoscope to explore the subgingival spaces around implants with or without signs of peri-implant inflammation. The majority of diseases population (80.95%) had retained cement whereas controls showed none[92]. The inflammation could be ascribed to the creation of rough surfaces by leaving excessive cement in the subgingival space, promoting the biofilm formation. The cement leaving more excess tend to have greater peri-implant bone loss and higher prevalence of peri-implant inflammation[93]. Moreover, modifications on implant abutment and cementation techniques were also introduced to limit the amount of cement extending into the gingival sulcus of implant-retained crowns[94,95]. Fortunately, most of the cement-associated peri-implant diseases could be solved following complete removal of residual cement[92]. Recently, the use of zinc oxide-eugenol cement is advocated since the subgingival residuals could be dissolved in the sulcular fluid[93]. Further studies are still needed to prevent the peri-implant inflammation induced by residual excessive cement.

Conclusion

The relationship between prosthodontics and periodontics is intimate and inseparable. Robust supporting periodontal/peri-implant tissues provide solid foundations for predictable prosthetic therapy. In addition, regaining stable periodontal conditions should rely on establishment of proper contact types, occlusal scheme and quality prosthesis. Frequent and efficient communications are essential between periodontists and prosthodontists through the entire treatment procedures, including plan, treatment procedures and maintenance, since both specialty share a common goal: to create pleasing esthetic with a harmonious stomatognathic system.

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Case Report

Retrograde Peri-Implantitis: A Case Report

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Abstract

Retrograde peri-implantitis is one of the implant complications when inflammation occurs around the fixture apex. The treatments of retrograde peri-implantitis mostly entail surgical debridement and antibiotic therapy. In this case report, we treated the apical lesion of the implant simply by nonsurgical root canal treatment with antibiotic therapy at the neighboring asymptomatic The case report reveals that elimination of the possible predisposing factor from adjacent endodontic-treated tooth is much more conservative and may be the key to the success outcome.

Keywords: Retrograde peri-implantitis, implant complications

Introduction

The success rate of implants increases due to improved implant surface design and optimal implant surgery guidelines. The widely accepted criteria for implant success that were proposed by Albrektsson et al.[1] in 1986 are as follows: (1) an individual, unattached implant that is immobile when tested clinically; (2) a radiograph that does not demonstrate any evidence of peri-implant radiolucency; (3) vertical bone loss that is less than 0.2 mm annually subsequent to the implant's first of year service; (4) implant performance that is characterized by an absence of persistent and/or irreversible signs and symptoms such as pain, infections, neuropathies, paresthesia, or violation of the mandibular canal; and (5) a successful rate of 85% at the end of a five-year observation period and 80% at the end of a ten-year period within the context of the other criteria above. Due to the increasingly common utilization of implants, strategies to prevent implant complications have become a big issue among clinical practitioners.

Retrograde peri-implantitis is one of the implant complications that occur wheninflammation occurs around the fixture apex. It is rarely discussed and there is no consensus on the management of retrograde peri-implantitis. According to a report by Zhou et al.[2], the incidence of retrograde peri-implantitis is 7.8%. Laird et al.3 showed that the success rate and survival rate of implants decrease when non-vital teeth are nearby. Possible etiologies of the periapical lesions of the fixtures are: (1) bacterial contamination from an extracted socket or neighboring remaining teeth; (2) close dis-

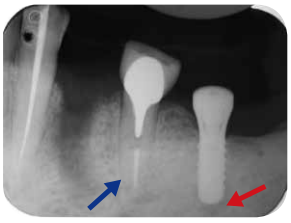

fig. 1 The lower left second premolar was endodontic-treated with asymptomatic apical lesion (blue arrow) and the lesion was noted at 36 implant apex (red arrow).

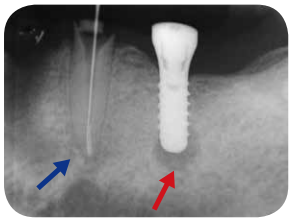

fig. 2 Tooth 35 was under non-surgical root canal treatment (NSRT) to exclude bacterial contamination of the implant from the adjacent tooth.

fig. 3 The NSRT of tooth 35 was then accomplished by the lateral compaction technique.

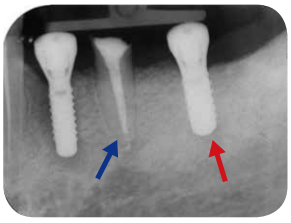

fig. 4 The periapical lesion of tooth 35 (blue arrow) and the implant area of 36 (red arrow) healed well without surgical intervention.

fig. 5 Six months follow-up after 36 implantation.

fig. 6 The implant is stable and functioning well.

tances between the fixture and the adjacent teeth; (3) bone necrosis due to overheating during implant site preparation; (4) implant insertion short of the prepared osteotomy site. Most treatments of retrograde peri-implantitis entail surgical debridement and surface treatment of the exposed portion with antibiotics. In this case report, the patient presented with retrograde peri-implantitis affected by the asymptomatic periapical pathology of adjacent teeth. After ineffective anitibiotic therapy, we treated the retrograde peri-implantitis with nonsurgical root canal treatment at the neighboring tooth and cured the symptoms and apical lesion.

Case report

The patient, a 72-year-old male with hypertension under medical control, came to visit us for a full-mouth dental examination due to multiple missing teeth. Gingival swelling and pus formation were noted in the region of the lower left premolars. The lower left first premolar was extracted on February 4th, 2008, due to a vertical fracture, and the lower left second premolar was endodontically treated after an asymptomacitc apical lesion was revealed on the x-ray film (fig.1). After the extraction of tooth 34, antibiotics (Amoxicillin, 500 mg 4 times daily for 7 days) were prescribed to control the inflammation.

While waiting for the tooth 34 area to heal, we placed an implant (ITI standard plus, SLA10 mm, 4.1 mm RN) at the lower left first molar edentulous area on July 3rd, 2008. Healing was uneventful during the first couple weeks; however, the patient started to complain of continuous pain at the implant site 1 month after the implant was inserted. The x-ray film (fig.1) revealed a developing apical lesion at implant 36. The percussion pain and palpation pain were positive in the implant 36 area but negative on tooth 35, and the pocket depth of later tooth was within normal limit. Amoxicillin (500 mg 4 times daily for 7 days) and metronidazole were prescribed, but the pain persisted. To prevent bacterial contamination of the implant from the adjacent tooth, tooth 35 was subjected to nonsurgical root canal treatment (NSRT) after the removal of the metal post and core (fig.2). Calcium hydroxide (as an interappointment dressing) and sodium hypochloride irrigating solutions were applied during NSRT. The symptoms and signs subsided right away, and the NSRT of tooth 35 was then accomplished by the lateral compaction technique with guttapercha and calcium hydroxide based sealer (Sealapex™ Root Canal

Sealer) (fig.3). The follow-up x-ray film showed that the periapical lesion at tooth 35 and the implant 36 area healed well without surgical intervention (fig.4). A periapical radiograph (fig. 5) taken 6 months after 36 implantation showed no significant radiolucency at apical region of 36 fixture. The implants were asymptomatic and appeared to be stable and functioning well(fig. 6).

Discussion

Implant-supported fixed dental protheses (FDPs) are widely used due to their favorable long-term outcomes. The 5-year and 10-year survival rates of implant-supported FDPs are estimated to be up to 95.6% and 93.1%, respectively.[4] Considering the biological and mechanical prothesis designs, treatment plans with implants are the optimal option under many circumstances. Due to the increased utilization of implants, strategies to prevent implant complications have become a big issue among clinical practitioners.

Among various implant complications, one rarely discussed complication that occurs when inflammation occurs around the fixture apex is retrograde peri-implantitis. The potential causes to retrograde peri-implantitis vary. Laird et al.[3] compared the success rate and survival rate of implants which are adjacent to vital teeth with those of implants which are adjacent to non-vital teeth. Even though the sample size is insufficient, the implant success rate and survival rate decrease when non-vital teeth are nearby, a finding which suggests that the conditions of neighboring teeth influence the success of implant surgery. Zhou et al.[2] showed that the incidence of retrograde peri-implantitis is 7.8%, and among the 10 cases of retrograde peri-implantits in their study, 9 of the failed implants were adjacent to non-vital tooth. Furthermore, their report also mentioned that the greater the distance between the pulpless teeth and the failed implants, and the longer the duration from endodontic treatment to implant placement, the lower the incidence of retrograde peri-implantitis. In a retrospective study conducted by Quirynen et al.[5], retrograde peri-implantitis was found to have occurred preferably at sites with a history of obvious endodontic pathology in the extracted tooth to be replaced. This seemed to indicate that the complication is provoked by remaining scar or granulation tissue at the recipient site. In conclusion, possible etiologies of the periapical lesions of the fixture are varied and can be categorized as follows: (1) bacterial contamination from the extracted socket or neighboring remaining teeth; (2) close distances between the fixture and the adjacent teeth; (3) bone necrosis due to overheating during implant site preparation; and (4) implant insertion short in distance from the prepared osteotomy site.[6, 7]

There is no consensus treatment for retrograde peri-implantitis. Some case reports have reported the use of surgical debridement and surface treatment of the exposed portion with antibiotics,[7, 8] while others have reported a combination of implant removal and re-implantation.[9-12] The authors of most of those reports have indicated the belief that any infected implant should be removed as soon as possible to prevent osteomyelitis. However, as detailed in this case report, after ineffective anitibiotic therapy, we treated the apical lesion of the implant simply by nonsurgical root canal treatment at the neighboring asymptomatic tooth rather than by surgical intervention, an approach which is much more conservative. The key to the successful outcome seemed to be the possible predisposing factor of the elimination of the adjacent endodontically treated tooth. This case report may be the first in which a conservative approach was used to treat retrograde peri-implantitis and can thus serve as a reference for the treatment of retrograde peri-implantitis.

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Case Report

Providing a Removable Partial Denture with Metal Posterior Occlusal Surface to a Patient with Nasopharyngeal Carcinoma

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Abstract

A patient with a history of nasopharyngeal carcinoma (NPC) and radiation therapy presented inadequate inter-occlusal space and severe occlusal wearing. A lower denture designed with metal occlusal surface was fabricated for the compromised dental status.

Key word: **Nasopharyngeal carcinoma, limited restorative space, removable partial denture with metal occlusal surface**

Introduction

Nasopharyngeal carcinoma(NPC) is a malignancy that arises from the lining epithelium of the nasopharynx. NPC patients are typically treated with large irradiation dose at all the major and minor salivary glands, thus caused severe and persistent xerostomia. The side effects of such treatment impact the quality of life. Complications include candidiasis, as a result of a shift in the oral microora; transient taste alterations with nutritional compromise and accompanying weight loss, and trismus, due to muscle fibrosis which may lead to restricted movement of the mandible[1-4].

In NPC patient[3], pre-radiotherapy consultation in dental clinic is needed. Since the long-term maintenance of teeth depends profoundly on good patient compliance with specific home care and preventive measures, patients must be encouraged to become actively involved in their oral health care program. Fluoride gel and chlorhexidine rinses may be used to control cariogenic flora during and after radiation therapy. And preventive extraction of those teeth with non-restorable caries, active periapical disease, moderate to severe periodontal disease, lack of opposing teeth and difficult to maintain oral hygiene, partial impaction or incomplete eruption, etc, must be done before radiation therapy to prevent osteoradionecrosis(ORN)[5,6].

Post-radiation instruction is also very important. Maintenance of a prosthesis is more challenging because a dry oral environment renders the patient more susceptible to candidal infections[7,8], mucosal irritation[7], and decreased healing of hard and soft tissues made friable by radiation[9]. The absence of saliva also can lead to a shift to a more cariogenic diet that the patient perceives as more pleasant in taste

a. Maxillary occlusal view

b. Mandibular occlusal view

c. Frontal view, habitual closure position

d. Frontal view, open mouth

e. Right lateral view, closure position

f. Left lateral view, closure position

fig. 1 Intraoral finding

fig. 2 Panoramic film

and texture. Frequent followup visits should be initiated. Compliance with uoride application, degree of xerostomia, mucositis, taste alterations and signs of candidal or other microbial infection should be assessed during these recalls.

In this case, the patient had been consulted to dental department before radiation therapy, however, because of the fear of dental extraction, and the worry of NPC prognosis, the patient refused pre-radiation dental treatment. After 1 year treatment of NPC, patient came to our dental department due to the complication of radiation, including xerostomia, and poor oral and dental condition, he could not eat well, and this body weight was lost. Therefore he came to our department again for help.

Case report

The patient, a 67-year-old male with hypertension who had undergone a coronary angioplasty with stent placement, was diagnosed with NPC in June of 2013 and was informed by his physician at that time that he had six months left to live. One month later, he was treated with surgical excision, chemotherapy, and radiotherapy.

In August of 2014, the patient, who was suffering from a post-therapy oral complication, xerostomia, presented to our department for full mouth rehabilitation with complaints about inefficient chewing ability.

At presentation, the patient's oral hygiene was very poor, and a large amount of plaque and food accumulation were noted. Therefore, the following issues were all detected: poor oral hygiene combined with post-radiation xerostomia, severe chronic periodontitis, and extensive decay. Moreover, insufficient restoration space and a loss of posterior support that led to anterior wearing facets were revealed after clinical (Fig. 1) and radiographic (Fig. 2) examinations.

At the circumstance without tooth extrac-

a. Maxillary occlusal view

b. Mandibular occlusal view

fig. 3 Wax up of restored worn dentition

a. 33.34 metal crowns delivery

b. Restore the wearing facet with composite resin on 13.12.22.22.23.24

fig. 4 Restored dentition before denture fablrication

a. Wax pattern on maxillary refractory cast

b. Wax pattern of posterior occlusal surface on mandibular refractory cast

fig. 5 Wax up for cast metal framework of partial dentures

tion for prevention osteoradionecrosis (ORN), a sequential treatment that consist of endodontic treatment which was performed on 15 and 35, full mouth prosthetic restoration was planned. Tests were conducted to evaluate the patient's extra-oral profile, swallowing ability, and the free space of about 6 mm. A diagnostic impression was made with alginate, and the diagnostic cast was then mounted on an articulator after being poured with dental stone. The vertical dimension was raised 2 mm higher on the articulator to regain sufficient space to perform a wax-up on the worn teeth numbered 11, 12, 13, 23, 24, 25, 32, 33, 34, 43 in order to improve their morphology (Fig. 3). Based on the diagnostic wax-up, the wearing facets were restored with composite resin and 33.34 metal crowns were constructed in light of the new occlusal vertical dimension (OVD) and delivered to the patient (Fig. 4).

A final impression was made with an individual tray and vinyl polysiloxane material for removable partial denture fabrication. Upon the master cast, fabricating upper and lower occlusal rims and inter-occlusal relationship in centric relation was registered. The record was then transferred to an articulator via facebow transfer. Furthermore, a refractory cast was made and mounted to allow the preparation of the wax pattern for the denture framework with posterior occlusal surface (Fig. 5). This was followed by investing the framework with cobalt-chromium alloys. The framework was seated in patient's mouth (Fig. 6) to check the

a. Maxillary framework

b. Mandibular framework with posterior metal occlusal surface

fig. 6 Removable partial denture framework try-in

a. Maxillary occlusal view

b. Mandibular occlusal view

c. Frontal view

d. Right buccal view

e. Left buccal view

fig. 7 Denture delivery. The mandibular denture has metal occlusal surface

fit of its components, and the occlusion was accessed and adjusted via inspection and the use of articulating paper.

As to the artificial teeth arrangement, the upper teeth consisted of acrylic material, and the lower RPD included a metal occlusal surface to compensate for the insufficient space between the upper and lower arches. Then the upper and lower dentures were delivered, although it should be noted that the esthetics were inevitably compromised in this case (Fig. 7).

Commonly, dental care for patients with NPC must be commenced before the initiation of cancer therapy; however, in the case of this patient, who had already been through radiation and chemotherapy, post-treatment support and management, which included maintenance visits at 3-month intervals, oral hygiene instruction, and the application of moisturizing mouth gel and fluoride, had to be provided by the patient's dentists.

Discussion

For an NPC patient, pre-radiotherapy consultation in a dental department is typically necessary. Those teeth which can be saved should be restored before the patient undergoes radiation therapy, and the preventive extraction of those teeth which are too difficult to treat or which impair oral hygiene maintenance should also be performed prior to radiation therapy[1, 2]. Furthermore, post-radiation instruction is also very important.

In this case, we did not want to plan a treatment that would be too complicated and difficult given the patient's already highly compromised condition. A restricted interarch

space at the posterior edentulous ridge is a result of long-term loss of the posterior teeth that leads to the extrusion of opposing teeth and/or wear on the remaining natural teeth[3-6]. A casting metal occlusion and metal denture base may be indicated when the opposing dentition is in close approximation to the edentulous alveolar ridge, especially if the use of a conventional removable partial denture with a resin denture base and acrylic resin teeth is precluded[7]. In this case, in consideration of the difficulty of any future relining or rebasing of a metal denture base, the patient's denture mainly employed resin denture base and metal mesh to facilitate future repair.

A metal occlusal scheme has the advantages of the inherent physical properties of metal, such as wear and fracture resistance; however, its disadvantages include compromised esthetics, the increased weight of the prosthesis, wear on opposing teeth, difficulty in occlusal adjustment, and the need to mount a refractory cast in an articulator to develop occlusion, among others[8]. However, the patient was satisfied with his mastication ability, which was significantly improved, and the results showed that the applied denture designs are effective and suitable for patients with a reduced interarch distance.

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Literature Review

下顎運動時顳顎關節之應力分析
Stress Analysis of the Temporomandibular Joint during Mandibular Movement

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摘要
人類下顎骨是由兩側顳顎關節（temporomandibular joint）與頭骨相連，此關節可提供下顎骨與顱骨間有相當大之活動性，雖然顳顎關節表面不平滑，但中間有一軟骨性關節盤（cartilaginous articular disc），被認為可使不平滑關節表面間接之觸面積增加，減少接觸時產生之壓力。早期認為哺乳動物之顳顎關節並非承重關節（loading-bearing joint），然而，亦有其他學者表示，顳顎關節因咀嚼系統作用，會有很重的負載（heavily loaded），當力量過大時，甚至有可能會進一步造成顱顎障礙症（craniomandibular disorders）。因此，瞭解咀嚼力量是否會傳遞到顳顎關節及其程度大小，是很重要之議題，可幫忙臨床評估與診斷治療。很多關於人類咀嚼系統的實驗性方法與數學性模型，都被用來說明及預測這些作用在關節上之力量，其中利用有限元素法，可以模擬包含關節盤的顳顎關節受力大小與分佈，這些分析包括模擬二維或三維的顳顎關節生物力學與特性，有助於我們瞭解關節之運作。

關鍵詞：顳顎關節、應力分析、有限元素法

Abstract
Human mandible is connected to the skull with bilateral temporomandibular joints which could provide considerable movement between the mandible and skull. The cartilaginous articular disc in temporomandibular joint is considered to increase the articular surfaces and reduce the contact stress, although the surface of temporomandibular joint is not smooth. In early period, it was believed that temporomandibular joint of mammals was not a load-bearing joints. However, other researcher postulated that temporomandibular joint could have heavily load during masticatory function sometimes may lead to the occurrence of craniomandibular disorder. Therefore, to study the chewing forces passed to the temporomandibular joint and the amount of loading was very important. Many experimental methods or mathematical models of the human masticatory system have been used to illustrate and predict the loading of the joints, such as the finite element analysis through the simulation of two or three dimensional biomechanics of the temporomandibular joint.

Keywords: Temporomandibular joint, stress analysis, finite element method

前言

早期因為缺乏有關顳顎關節作用力（reaction force）之資訊，認為哺乳類動物顳顎關節並非一個承重關節（load bearing joint），在下顎運動及咀嚼作用時，關節不會有作用力。但在1950年左右，開始有學者認為顳顎關節在咀嚼的過程中，會有負載（load）存在。然而對於兩側關節的受力差別，亦或那一側會有作用力存在，則各有爭論[1,2]。理想上，直接針對下顎骨與顳顎關節去量測作用力的強度與方向即可區別其差異，例如利用動物實驗去探討關節內反應力之狀況。但實際上卻會有許多限制，且這類實驗十分不易操作，此外，手術方式暴露出關節，同時也會造成組織破壞，而影響其真實情境[2,3]。

因此利用間接方法去觀察關節作用力開始被重視，包括利用人類大體下顎骨去模擬肌肉咀嚼時之狀況。可惜結果不夠精確，因為大部分模型只模擬主要肌肉作用，缺乏實際肌肉作用強度，使得模擬髁頭負載時，會因為肌肉強度與方向設定不一樣，而有不同結果。或利用理論性模型（theoretical model），根據力量強度與方向去計算髁頭之負載。其他亦有利用雙折射材料（birefringent materials）組成下顎骨模型。然而此方式未考量骨小樑結構，可能會造成應力場（stress field）不同。或利用肌電圖（electromyography）觀察，將肌電活動（electrical activity）轉換成機械性力量（mechanical force）。不過肌電圖只能提供肌肉相對強度，無法提供負載方向之資訊。另外，所得強度也會與電極位置有關，或是受到電極與肌肉間組織影響，造成結果比實際強度還小[3,4]。

本文著眼於顳顎關節應力分析之文獻回顧，分別就實驗性方法與數學性模型去探討顳顎關節承重之特性與應力分佈。

實驗性研究（experimental studies）

（1）動物實驗（animal studies）：

咀嚼系統與顳顎關節解剖構造大部分在早期就已經被研究透徹，但對於咬合力在人體作用時，顳顎關節之作用力強度與方向卻一直未能完全明瞭。Hylander[1]在猴子顳顎關節韌帶（temporomandibular ligament）下置放應變規（strain gauges），讓猴子咬食物、木棍或特製之咬合力轉換器（bite-force transducer），記錄前牙咬合（incisal biting）、咀嚼食物、以及咬木棍或咬合力轉換器時之骨頭應變（bone strain）。結果發現顳顎關節在咀嚼用力咬、切斷食物以及咬轉換器時會呈現壓應力（compressive reaction force），並且在咀嚼時，對側關節會有較大之作用力，而同側關節則會依咬合位置而有明顯差異。在小臼齒或前兩顆大臼齒時，關節會有壓應力出現，往後到第三大臼齒處壓應力會減少、甚至消失或出現張力之現象。

此外，Brehnan等人[2]直接在猴子顳顎關節測量負載大小，將9 μm之感壓薄片（pressure sensitive foil）植入猴子關節，並黏著固定，接著為避免體液滲漏到轉換器系統造成短路，利用鐵氟龍線（teflon-coated wire）沿皮下至猴子頭顱骨頂端，手術完成後並做校正動作，最後結果得到：（a）在後牙咀嚼軟性及硬性食物時，髁頭會有一個較小之承重，約1~3磅，（b）在前牙咬合時，髁頭則會有一個較大之承重約3~4磅。

由於Hylander所建構之模型並未紀錄傳導至髁頭的力量有多少，因此Hohl[5]Tucek[3]為了維持顳顎關節的完整構造，僅取代髁頭頸部位置而保留髁頭，利用狒狒下顎骨設計一實驗，記錄確實作用在髁頭上之力量強度與方向，但由於實驗誤差與限制，亦無法證明咬合力與關節作用力之關係。一直到了1990年，Boyd等人[4]鑑於先前動物實驗多失敗於體液滲漏所造成，改用沒有連接器之遠端裝置，連結到遠控系統接收FM訊號，解碼轉換成力量記錄，結果發現猴子咀嚼時，關節作用力在工作側平均比非工作側多1.4~2.6倍，同時亦發現咀嚼時有一個在最遠端的單側咬合干擾，會使關節作用力減少一半甚至更多，並且猴子會拒絕用干擾側咬東西。

（2）體外實驗（in vitro studies）：

在顳顎關節漸漸被視為載重關節之後，學者開始探討關節受力後之特性與機轉，其中不乏對於關節盤（disc）之相關研究，因為關節盤對於關節中應力與應變影響，扮演著重要角色。因此Beek等人[5]利用特製材料試驗機（modified universal testing machine）去測試人類大體關節盤，進而探討關節盤之生物機械行為（biomechanical behavior），發現關節盤有吸收應力之作用，

並且在關節盤中間區（intermediate zone）會有較高的抵抗形變力量。另一方面，從組織學解釋，關節盤含有膠原纖維，在中間區為前後走向（anteroposteriorly），在前後帶（anterior and posterior bands）則為內外走向（mediolaterally），因此液流（fluid flow）在中間區會沿著纖維走向（前後向），順著方向到前後帶轉變成內外向，使得液流被限制住，增強中間區能量消散之能力，意即此區若有負載出現，並且當負載增加造成中間區表面性質越來越硬時，形變分佈會轉往抵抗形變能力較低的區域，使得形變區域變廣，增加關節表面接觸面積，減少應力集中。

此外，早期認為關節盤是線性彈性（linearly elastic），然而後來發現此軟骨性組織，除了包含一些固體基質如：膠原纖維與蛋白醣…等，尚有組織間液在其中流動，造成關節盤有著黏彈特性（viscoelastic properties），並且具有區域差別性（region specific），於是Kuo等人[6]利用動態黏彈機械分析儀（Dynamic Mechanical Analyzer）針對人類大體關節盤做了潛變與動態抗壓試驗，發現在關節盤前區與後區之聚合係數（aggregate modulus）大概是其他中央三區的三分之一，滲透壓則多了40%左右，而複合係數（complex modulus）中間三區大概是前區與後區的2.5~3倍，其推論這些差異可能與關節盤各區所含水量及蛋白醣不同有關。

數學性模組（mathematic models）

（1）簡單模組（simple models）：

數學模組是有力的工具，可用來間接預測關節受力後之表現與應力分佈，初期學者僅利用簡單的向量方式去推估關節作用力，如Barbenel[7]將主要咀嚼肌作用化做直線向量探討，結果顯示關節在功能運動時確實為載重關節，並且關節之受力強度會隨著咬合載重角度（occlusal load angle）增加而提高，此外，咬合載重之位置相對於髁頭距離越大也會增加關節受力。然而此模組過於簡化，因此Koolstra等人[8]根據影像分析，將16條咀嚼相關肌肉化作向量，然後針對不同咬點位置與下顎位置，去模擬靜態咬合力及其伴隨而來之關節反應力，結果得到咬合力會產生大範圍作用力，並且咬合作用力會在非工作側關節靠內側部位與工作側關節靠外側部位有較大的關節受力。

（2）有限元素分析（finite element analysis）

有限元素法從1940年代開始發展，15~20年後，被証實可當作適當工具來評估與測量複雜外型結構。此後便有許多學者利用有限元素法來做骨頭或相關結構之應力分析。1994年Chen與Xu[9]率先利用動態分析方法決定髁頭位移位置，再建立二維顳顎關節有限元素分析模型，其模型包含髁頭、關節盤、下顎窩與關節隆突。關節盤設定為彈性體（elastic body），骨性部分則為硬體（rigid body），另外包含三條韌帶之模擬，並設定為非線性彈簧，最後結果得到在關節盤之關節隆突相對位置以及中間區會有較大的應力集中，但礙於實驗限制與二維模組資訊有限，並無法完整呈現關節作用力與應力分佈狀況。

於是Beek等人[10]利用電磁軌跡量測系統（magnetic tracking device）量測顳顎關節之關節表面與幾何外形，並設定關節盤各區域厚度、楊氏系數（Young's modulus）以及浦松比（Poisson's ratio），摩擦力則忽略不計，結果發現應力集中在關節盤中間區的外側，與臨床上常見之破孔（perforation）位置一致，此外，在後續研究中，Beek等人利用類似模型去探討顳顎關節在不同位置以及軟骨性結構的應力[11]，發現在髁頭軟骨位置會有較大之變型量，而前突位置可看到關節盤載重區域轉移至中間區靠外側位置，顳骨軟骨結構之應力則是轉移至關節隆凸後方斜坡（posterior slope of the eminence），意即關節接觸區域通常為受力較大之處。

然而，有關顳顎關節模型尚未完整建立，因此Palomar與Doblare[12]嘗試利用磁共振與電腦斷層重組顳顎關節模型，並加入關節盤膠原纖維走向之考量，模擬牙齒緊咬時狀況。結果顯示纖維加強之關節盤（fiber-reinforced disc）相較於同質性（isotropic solid phase）之關節盤變型量會較小。此外，同質性關節盤應力分佈在中間區兩端，纖維加強之關節盤則分佈於中間區，而孔壓力（pore pressure）比同質性基質（isotropic solid matrix）多了約60%，其應力則會降低。

此外Palomar與Doblare[13]亦利用動作測量系統（motion measurement system）模擬側方運動時，關節盤之應力分佈狀況，結果發現：（1）最大主應力在同側會集中在後帶（posterior band），推測可能是因為顳顎關節

韌帶將髁頭往後外側方所造成，而對側應力則會集中在前方內側位置；（2）最小主應力會集中在同側後外側方，這可能是因為關節盤往後、往外對抗顳骨所造成；（3）剪應力則會集中在同側後帶外側方，並且對側受力比同側小，而臨床上關節盤常發生之外側破洞，可能就是因為此剪應力所導致而成。

結論

從1920年代，學者認為顳顎關節並非承重關節（non-bearing joint），到1950年代左右，漸漸發現顳顎關節確實會有作用力存在，此後探討顳顎關節之應力分析便是研究主要目標，1970~80年代，有許多學者利用動物實驗，希望能直接測量出關節所受應力大小與方向，但受限於實驗操作困難與限制，以及手術暴露關節，破壞關節結構後，所得結果並非真實狀況，於是，學者提出許多間接方法，希望能有效評估關節的應力大小與分佈，其中有限元素法在近代被廣泛應用，隨著顳顎關節各組織結構特性之確定，以及其它輔助裝置的進步，有限元素法模組從二維到三維，越來越能精準地模擬出顳顎關節之狀況，雖然因為許多假設性設定，使得結果仍未能顯示關節真實情境，無法定量出應力大小，但可提供我們一個定性結果，去了解應力分佈狀況。往後若能有更精準的模型設定，便可利用有限元素法有效地分析顳顎關節之應力大小與分佈，提供臨床上診斷與治療效果之輔助評估。

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