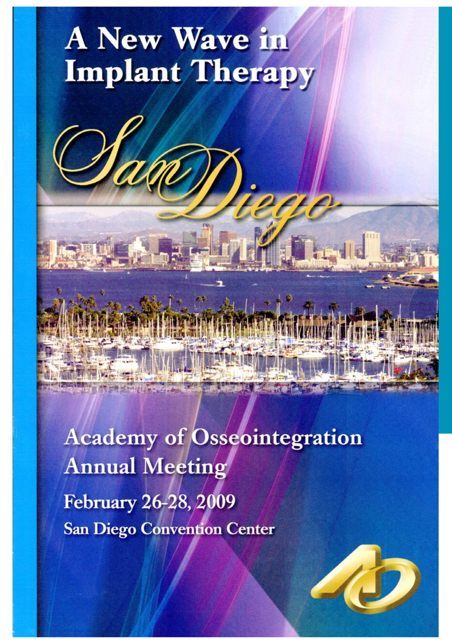

The Effect of Moldable Tissue on the Papilla Formation Around Implant Restorations

Hanawa, Yasufumi; Vavalekas, Michail; Dunca, Flaviu; Froum, Scott; Saito, Hanae; Kye, Wayne; Cho, Sang-choon; Froum, Stuart; Elian, Nicolas; Tarnow, Dennis. Ashman Department of Periodontology and Implant Dentistry, New York University

New York University

INTRODUCTION

Successful osseointegration of dental implants is well documented in the literature (1-6). The criteria for success in implant dentistry has changed from obtaining successful osseointegration only, to achieving osseointegration and aesthetic integration of prosthetic and soft tissue frameworks. One of the main challenges in implant dentistry continues to be the achievement of a stable and predictable aesthetic result including both the presence of an interproximal papilla and a harmonious mid-buccal gingival architecture. Inadequate dimensions of soft tissue can result in physical deformities, phonetic impediments, and food impaction.

There are a number of surgical and prosthetic techniques used to maintain the integrity of the peri-implant soft tissue. These include atraumatic tooth extraction with or without immediate placement and provisionalization (7-11), papilla sparing incisions for stage one and two procedures (12), and platform switching as a means of maintaining crestal bone levels. Platform switching is the placement of a smaller diameter abutment on a larger diameter implant platform (13). There are also a number of techniques suggested for regenerating lost papillae and mid-buccal tissue. Examples include soft tissue grafting, forced eruption, guided bone regeneration, and tissue manipulation with the provisional restoration (14-15). Even with proper execution of these techniques, if the soft tissue is unable to conform to the implant restoration the result will not be satisfactory to the patient or clinician. This occurs when soft tissue becomes rigid and non-flexible because of increased scar tissue formation in response to traumatic manipulation or previous surgical interventions. This tissue type does not allow adaptation or flexibility around implants. On the other hand, tissue that is resilient, flexible, and able to be adapted or shaped around an implant is desirable. We will identify tissue with these qualities as "moldable tissue" (Fig. 1, 2).

Moldable tissue is a key element in implant esthetics and is maintained by proper incision design, gentle handling, and adequate hydration during surgery. Another method of creating moldable tissue is with soft tissue grafting.

The purpose of this litereature review and case report was to demonstrate proper treatment planning, case selection, and surgical techniques that can preserve and increase the moldable tissue around an implant and discuss how moldable tissue can be achieved.

MATERIALS AND METHODS

Clinical data in this study was obtained from the Implant Database (ID). This data was extracted as de-identified information from the routine treatment of patients at the Ashman Department of Periodontology and Implant Dentistry at the New York University College of Dentistry (NYUCD) Kriser Dental Center. The ID was certified by the Office of Quality Assurance at NYUCD. This study is in compliance with the Health Insurance Portability and Accountability Act (HIPAA) requirements and approved by the University Committee on Activities involving Human Subjects.
This literature review includes a total of 211 articles from peer reviewed journals published in English from January 1986 to January 2009 were collected from a research performed using MEDLINE at the Waldman Library at the NYUCD Kriser Dental Center. The keywords utilized were "labial tissue" (23 articles), "papilla regeneration" (6 articles), "inteproximal papilla" (20 articles), "soft tissue management" (162 articles). **The inclusion criteria for article consideration included:**

1. Human clinical studies
2. Animal studies
3. Differences in gingival tissue biotype
4. The biological processes of healing and scar tissue formation
5. Articles included information regarding soft tissue around implant restorations
6. Regeneration of the soft tissue papilla
7. Surgical flap techniques and manipulation of the soft tissue flap
8. Extracellular matrix formation

Twenty-one articles of the 211 collected satisfied the studies inclusion criteria and were evaluated.

RESULTS

The results from the literature review revealed that there is a difference between "moldable tissue" and "non-moldable" scar tissue (Table 1).

The results also showed that the ability of a tissue to be moldable differs between different techniques (Table 2).

DISCUSSION

The biology behind moldable tissue relies on the resilience of the gingival tissue. The extracellular connective tissue matrix is produced by fibroblasts. This extracellular matrix (ECM) is composed of glycoproteins and proteoglycans containing glycosaminoglycans. The presence of large, flexible-chain, and negatively charged macromolecules on glycosaminoglycans regulate diffusion and fluid flow through the extracellular matrix (16). Due to their structure and hydration, macromolecules exert resistance towards deformation. Thus, when the gingival tissue is placed under pressure the macromolecules are deformed. Removing the pressure causes the macromolecules to regain their original form (16). This allows the molding of tissue with intermittent pressure. In normal healing, fibroblasts forming the ECM do not lead to scar tissue formation if they are not prematurely activated by a rigid ECM (16). But with a rigid substrate (i.e. implant), fibroblasts become prematurely activated and form excess fibrotic tissue leading to scar tissue formation (16). The excess fibrotic tissue is dense, rigid, difficult to mold, and significantly less vascularized (Fig. 3, 4, 5; Table 1).

Berglundh et al. (17) observed that the vascular system of the peri-implant mucosa originated solely from the blood vessels extending from the alveolar ridge. The connective tissue adjacent to implants contain few vessels, all of which are terminal branches of the supra-periosteal blood vessels. When incising into healthy tissue around a tooth, changes are initiated at the level of the vascular network. However, the same incisions in peri-implant tissue, which has a decreased vascularity, elicit a profoundly different and limited healing reaction. The healing potential of the peri-implant mucosa is not equal to that around natural teeth. Hence scar tissue appears, resulting in a less moldable soft tissue (Fig. 3).

Therefore, incision design and tissue handling around implants must address these differences (Fig. 6; Table 1). Clinicians need to alter their surgical technique in order to minimize scar tissue formation (Fig. 8). Maintaining the resilience and the moldability of soft tissue around implants requires atraumatic tissue handling, minimal tension during re-approximation, and suturing that avoids circulation impairment of wound margins which may lead to atrophy and/or necrosis (18) (Fig. 9, 10). This can be particularly problematic in submarginal flap designs, which result in difficult flap repositioning and more tension on the tissues (Fig. 10).

Trauma such as stretching, tearing, or distortion should be avoided by careful tissue manipulation (18-19) and expedient surgical procedures that decrease the risk of dessication of the tissues should be employed (Table 1). The tissues must be kept moist at all times to avoid shrinkage and dehydration (18).

Techniques such as papilla sparring incisions (Fig 6), immediate placement and provisionalization of implants (Fig. 1), and microsurgery have attempted to preserve, maintain, and create moldable soft tissue. Orthodontic tooth movement is one of the ways to create moldable tissue without surgical damage to the gingival tissues (Fig. 11). There are no incisions involved when extruding a tooth using orthodontic movement. The extrusion of a tooth is effective in increasing the height of the surrounding gingival tissues. The increased volume of tissue creates a therapeutic reserve of tissue which can be used when performing implant surgery in the esthetic zone, even in patients with a thin scalloped periodontium (20). Employing orthodontic movements allow native tissue to be moved. Distraction osteogenesis can move bone and soft tissue, but the directional forces are not similar to the ones used in orthodontic movement and incisions are made in the bone and soft tissue which compromise blood supply. While there is a progressive manipulation of the tissue using orthodontics which can increase moldable tissue, the same is not true with distraction osteogenesis (Table 2).

There exists a paucity of literature on scar tissue removal. One case report by Cranska proported to remove scar tissue on the interproximal papilla with a laser in order to regain the interdental papilla height (21). The author claimed that scar tissue was ablated with the laser and the stimulation of the gingival tissue caused proliferation of microvasculature and migration of fibroblasts. To date there has been no research presented to verify these claims.

More experimental and clinical trials are necessary to better understand the interaction on a cellular and molecular-biologic level. Such work will provide the basis for establishing highly specific and selective therapeutic approaches to reduce scarring and fibrosis and increase moldable tissue for papillary regeneration procedures in papilla regeneration procedures. Preservation of vascular supply and preventing formation of scar tissue are key elements in preserving tissue moldability. This is essential for successful implant therapy.

CONCLUSIONS

The biology behind moldable tissue relies on the resilience and flexibility of the gingival tissue. Maintaining the moldability of soft tissue around implants requires carefully planned incision design, atraumatic tissue handling, minimal tension during re-approximation, and suturing that avoids circulation impairment of wound margins which may lead to tissue atrophy and necrosis. Techniques such as papilla sparring incisions, immediate placement and provisionalization of implants, microsurgery, and orthodontic movement of natural teeth prior to extraction have attempted to preserve, maintain, and create moldable soft tissue.

"...moldable tissue is a key element in implant esthetics and is maintained by proper incision design, gentle handling, and adequate hydration during surgery..."

Fig. 1 Preserved moldable tissue

Fig. 2 Occlusal view of moldable tissue

Fig. 5 Relatively invasive incision

Fig. 6 Papilla preserved incision

Fig 9 Moldable tissue after restoration

Fig. 10 Moldable tissue after orthodontic movement

Fig. 3 Two GBRs and one CT graft lead to scar tissue

Fig. 4 Thick tissue but not moldable

Fig. 7 Excessive suture cause scar tissue

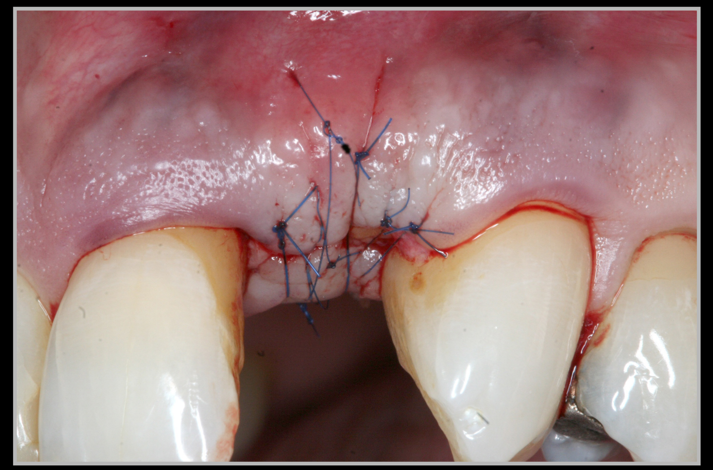

Fig. 8 Microsuture generate less scar tissue

	Moldable Tissue	Scar Tissue
Blood Supply	Sufficient	Poor
Biology	Fibrous tissue absent	Fibrous tissue present
Duration of Procedure	Short procedure	Long procedure
Tissue Handling	Gentle handling	Traumatic manipulation
Incision Design	Proper design allows tissue movement	Poorly designed incision does not allow tissue movement

Table 1 Differences between moldable and scar tissue

Techniques	Preserving / increasing moldable tissue	Success of technique
Immediate-implant placement / provisionalization	Preserving	+++
Orthodontic tooth movement	Increasing	+++
Soft Tissue/Connective Tissue Graft	Increasing	++
Papilla sparring incision	Preserving	++
Microsurgery	Preserving	++
Palacrestal incision for implant placement	Increasing	++
Guided Bone Regeneration	Increasing	±
Distraction osteogenesis	Increasing	_

Table 2. Different techniques for moldable tissue

REFERENCES

1. Branemark PI, Hansson BO, Adell R, et al. Osseointegrated implants in the treatment of the edentulous jaw. Experience from a ten-year period. Scand J Plast Reconstr Surg 1977; 16 (Suppl): 1-132.
2. Adell R, Lekholm U, Rockler B, et al. A 15-year study of osseointegrated implants in the treatment of the edentulous jaw. Int J Oral Surg 1981; 10:387-416.
3. Albrektson T. A multicenter report on osseointegrated oral implants. J Prosthet Dent 1988; 60:75-84.
4. Lazzara R, Siddiqui AA, Binon P, et al. Retrospective multicenter analysis of 3i endosseous dental implants placed over a five-year period. Clin Oral Implants Res 1996; 7:73-83.
5. Lekholm U, Gunne J, Henry P, et al. Survival of the branemark implant in partially edentulous jaws: A 10-year prospective multicenter study. Int J Oral Maxillofac Impl 1999; 14:639-645.
6. Buser D, Mericske-Stern R, Bernard JP, et al. Long-term evaluation of non-submerged ITI Implants. Part 1:8-year life table analysis of a prospective multi-center study with 2359 implants. Clin Oral Implants Res 1997; 8:161-172.
7. Froum SJ. Immediate placement of implants into extraction sockets: Rationale, outcomes, technique. 2005; 98:19-33.
8. Rosenquist B, Grenthe B. Immediate placement of implants into extraction sockets: Implant survival. Int J Oral Maxillofac Implants 1996; 11:205-209.
9. Kan J, Rungcharassaeng K, Lozada J. Immediate placement and rovisionalization of maxillary anterior single implants: 1-Year prospective study. Int J Oral Maxillofac Implants 2003;18:31-39.
10. De Kok I, Chang SS, Moriarty JD, Cooper LF. A retrospective analysis of periimplant tissue responses at immediate load/provisionalized microthreaded implants. Int J Oral Maxillofac Implants 2006; 21:405-412.
11. Covani U, Barone A, Cornellini R, Crespi R. Soft tissue healing around implants placed immediately after tooth extraction without incision: A clinical report. Int J Oral Maxillofac Implants 2004; 19:549-553.
12. Joseph Y Kan, Kitichai. K. Rungcharassaeng: Interimplant papilla preservation
in the esthetic zone: A report of six consecutive cases. Int J Periodontics Restorative Dent 2003; 23:249–259.
13. Lazzara RJ,Porter SS. Platform switching: A new concept in implant dentistry for controlling postoperative crestal bone levels. Int J Peri Rest Dent 2006; 26:9-17.
14. Salama S,Salama M, The role of orthodontic extrusive remodeling in the enhancement of soft and hard tissue profiles prior to implant placement. Int J of Periodontics Restorative Dent. 1993; 13:3:12-334.
15. David E.Grossberg. Interimplant papilla reconstruction: Asessment of soft tissue changes and results of 12 consecutive cases J of Periodont 2001; 72:958-962.
16. Pierre-Jean Wipff, Boris Hinz, et al. Myofibroblast contraction activates latent TGF-â1 from the extracellular matrix. The Journal of Cell Biology, 2007; 179: 6: 1311-1323.
17. Berglundh T. et al. The topography of the vascular systems in the periodontal and peri-implant tissues in the dog. J Clin Periodontol 1994; 22: 189-193.
18. Harrison J, Jurosky K. Wound healing in the tissues of the periodontium following periradicular surgery. I. The incisional wound. J Endod 1991; 17:425–435.
19. Tibbetts LS, Shanelec D. Current status of periodontal microsurgery. Curr Opin Periodontol 1996; 3: 118–125.
20. Salama H, Salama M, Kelly J. The orthodontic-periodontal connection in implant site development. Prac Periodontics Aesthet Dent 1996 ;Nov-Dec;8(9):923-32.
21. Cranska, Jeffrey. Laser soft-tissue therapy to regenerate a gingival papilla. Dentistry Today 2007; Dec.

This Presentation was Sponsored by New York University Department of Implant Dentistry Alumni Association (NYUDIDAA) and the Office for International Program