Dimension of the periimplant mucosa

Biological width revisited


Abstract. The objective of the present study was to determine the dimension of the mucosal-implant attachment at sites with insufficient width of the ridge mucosa. 5 beagle dogs were used. Extractions of all mandibular premolars were performed and 3 months later, 3 fixtures of the Brånemark System® were installed in each side. Following 3 months of healing, abutment connection was carried out. On the right or left side of the mandible, abutment connection was performed according to the Brånemark System® manual – (control side). On the contralateral side (test side), an incision not extending through the periosteum was made at the crest of the ridge. The soft tissue was dissected and a critical amount of connective tissue on the inside of the flap was excised. The periosteum was subsequently incised, abutment connection performed, and the trimmed flaps sutured. The sutures were removed after 10 days. After a 6-month period of plaque control, the animals were sacrificed, biopsies sampled and processed for light microscopy. The length of the junctional epithelium varied within a rather narrow range; 2.1 mm (control side) and 2.0 mm (test side). The height of the suprabony connective tissue in this model varied between 1.3±0.3 mm (test side) and 1.8±0.4 mm (control side). At sites where the ridge mucosa prior to abutment connection was made thin (<2 mm), wound healing consistently included bone resorption. This implies that a certain minimum width of the periimplant mucosa may be required, and that bone resorption may take place to allow a stable soft tissue attachment to form.

Key words: periimplant mucosa; attachment; histometry; biological width

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In a series of studies from our laboratory the structure and function of the keratinized, non-mobile gingiva and the corresponding periimplant mucosa were examined in the beagle dog model (Berglundh et al. 1991, 1992, 1994, Ericsson et al. 1992). The 2 tissues were found to have many features in common. Thus, both soft tissues included a junctional epithelium that was about 2 mm in "apico-coronal" direction and was separated from the bone crest by a zone of connective tissue attachment >1 mm high. The fibers within the supraalveolar tissue at the tooth site originated from the acellular, extrinsic fiber cementum on the root surface, while the majority of the fibers at the implant sites occurred in an avascular compartment and were apparently anchored in the periosteum of the bone crest. In a recent experiment in the dog (Abrahamsson et al. 1996), it was observed that the mucosal barrier that formed following successful 1- and 2-stage implant installations had similar composition, i.e. it was comprised of one zone of junctional epithelium and one zone of connective tissue. Furthermore, it was detected that at sites where the mucosa of the edentulous ridge was thin, (i) angular bone defects occurred at the marginal border of the implants, and (ii) the dimension of the mucosal attachment to the implant was similar to that of sites with a thick mucosa. This feature of the implant -- tissue interface was characteristic for both 1- and 2-stage implant systems. Abrahamsson et al. (1996) suggested that a certain width of the periimplant mucosa is required to enable a proper epithelial-connective tissue attachment, and if this soft tissue dimension is not satisfied, "bone resorption will occur to ensure" the establishment of attachment with a appropriate "biological width". The objective of the present study was to further test this hypothesis.

Material and Methods

5 beagle dogs, about 1 year old, were used. Extractions of all mandibular pre-
molars were performed. After 3 months of healing, fixtures of the Bränemark System® (length: 7 mm, ø: 3.75 mm; Nobelpharma AB, Göteborg, Sweden) were installed according to methods described by Berglundh et al. (1991). Each animal was fitted with 3 implants on each side of the mandible; in all 6 implants. Following a healing period of 3 months, abutment connection was carried out. On the right or the left side of the mandible, muco-periostal flaps were elevated, and abutment connection performed according to the Bränemark System® manual (control side). The flaps were sutured. On the contralateral side (test side), an incision not extending through the periosteum was made at the crest of the ridge. Using a blunt elevator, the soft tissue was dissected, and in order to obtain a thin ridge mucosa, a critical amount of connective tissue on the inside of the flap was excised. The periosteum was subsequently incised, abutment connection performed, and the trimmed flaps sutured. The sutures were removed after 10 days. A 6-month period of plaque control was initiated. This included daily cleaning with toothbrush and dentifrice. The animals were sacrificed with an overdose of Sodium-Pentothal and perfused through the bilateral carotid artery by a fixative (Karnowsky 1965). The mandibles were removed and placed in the fixative. Each implant region was dissected using a diamond saw (Exakt®, Kulzer, Germany). The tissue samples, comprising the implant and the surrounding soft and hard peri-implant tissues, were decalcified in EDTA and processed using a modification of the "fracture technique" (Thomsen & Ericson 1985) as described by Berglundh et al. (1994). Decalcification was performed in EDTA and dehydration performed in serial steps of alcohol concentrations. Secondary fixation in OSO₄ of the tissue samples was carried out and the units were finally embedded in EPON® (Schroeder 1969). Sections were produced from each tissue unit with the microtome set at 3 μm. The sections were stained in PAS and toluidine blue (Schroeder 1969).

Histometric analysis

In each section, the following landmarks were identified and used for the linear measurements: PM: the marginal portion of the periimplant mucosa; aJE: the level of the apical termination of the junctional epithelium; B: the marginal level of bone to implant contact; BC: the bone crest, i.e., the most coronal portion of the periimplant bone; A/F: the abutment/fixture junction. The distances between the landmarks were determined in an Olympus® Research Stereo Microscope connected to a PC (Compac®) equipped with an image system and a mouse cursor.

Results and conclusion

The vertical dimension of the periimplant mucosa (Fig. 1) in the control side, i.e., the distance between the bone crest (BC) and the outer surface of the oral epithelium (PM), was on average 3.65±0.44 mm. The corresponding mucosa in the test jaw was in 4 out of 5 jaw quadrants thin, on the average 2.4±0.23 mm, while in 1 test quadrant, the periimplant soft tissue had adopted dimensions similar to those characterising the dimensions of the control sites (3.3 mm).

The junctional epithelium of the periimplant mucosa at both the test and control side; of the mandible was consistently separated from the crestal bone by a zone of collagen rich and cell poor connective tissue. The length of the junctional epithelium varied within a rather narrow range: 1.3±0.3 (test side) and 1.8±0.4 mm (control side). At sites where the ridge mucosa prior to abutment connection was made thin (< 2 mm) and remained thin, wound healing consistently included bone resorption and the establishment of an angular bone defect (Fig. 1). This implies that a certain minimum width of the periimplant mucosa is required, and that bone resorption may take place to allow a proper soft tissue attachment to form. The present finding may in part explain the loss of alveolar bone that occurs during the 1st year following abutment connection and the subsequent loading of the implant system (Adell et al. 1981, Pilliar et al. 1991). It is suggested that once the implant is exposed to the oral environment and in function, a mucosal attachment of a certain minimum dimension is required to protect osseointegration.
Zusammenfassung
Die Abmessung der periimplantären Mukosa. Überprüfung hinsichtlich eines biologisch günstigen Durchmessers

Die Länge des Saumepithels schwankte in ziemlich engen Grenzen: 2,1 mm (Kontrollseite) und 2,0 mm (Testseite). Die Höhe des oberehaf des knöchernen Alveolarfortsatzes gelegenen Bindegewebes streute bei diesem Versuchsmodell zwischen 1,3±0,3 mm (Testseite) und 1,8±0,4 mm (Kontrollseite). An den vor der Fixation der Distanzhülsen dünn gestalteten Stellen der Mukosa des Alveolarkamms (<2 mm) ging die Wundheilung durchweg mit Knochenresorption einher. Das bedeutet, daß es einer gewissen Mindestbreite der periimplantären Mukosa bedarf. Um die Bildung eines stabilen weichgeweblichen Attachments zu erlauben, kann es zur Resorption des alveolären Knochens kommen.

Résumé
Dimension de la muqueuse péri-implantaire. Retour sur l'espace biologique
La présente étude avait pour but de déterminer les dimensions de l'attache muqueuse-implant dans des sites où la largeur de la muqueuse du rebord était insuffisante. Nous avons utilisé 5 chiens Beagle. Toutes les prémolaires inférieures ont été extraites, puis, 3 mois plus tard, 3 fixtures du Système Bråne mark* ont été mises en place de chaque côté. Après 3 mois de cicatrisation, on a pratiqué la connexion des piliers. Du côté droit ou gauche de la mandibule, la connexion des piliers a été faite conformément au manuel du Système Brånemark* (côté témoin=control). Du côté controlatéral (côté test), une incision ne traversant pas le péristome a été faite au niveau de la crête du rebord. Le tissu mou a été disséqué et une quantité critique de tissu conjonctif a été excisée de l'intérieur du lammedieu. Le péristome a ensuite été incisé, la connexion des piliers effectuée, et les lammedieux rectifiés ont été suturés. Les sutures ont été enlevées après 10 jours. Après une période de 6 mois avec élimination de la plaque, les animaux ont été sacrifiés; des échantillons ont été prélevés et préparés pour examen au microscope optique. La longueur de l'épithélium de jonction variait dans un intervalle assez étroit: 2,1 mm (côté témoin) et 2,0 mm (côté test). La hauteur du tissu conjonctif supra-osseux variait dans ce modèle entre 1,3±0,3 mm (côté test) et 1,8±0,4 mm (côté témoin). Dans les sites où la muqueuse du rebord avait été aménagée (<2 mm) avant la connexion du pilier, une résorption osseuse accompagnait toujours la cicatrisation de la plaque. Ceci indique qu'une certaine largeur minimum de la muqueuse péri-implantaire est nécessaire, et qu'une résorption osseuse peut prendre place pour permettre la formation d'une attache de tissu mou stable.

References


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