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The effect of mucosal cuff shrinkage around dental implants during healing abutment replacement

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SUMMARY **Soft tissue shrinkage during the course of restoring dental implants may result in biological and prosthodontic difficulties. This study was conducted to measure the continuous shrinkage of the mucosal cuff around dental implants following the removal of the healing abutment up to 60 s. Individuals treated with implant-supported fixed partial dentures were included. Implant data – location, type, length, diameter and healing abutments' dimensions – were recorded. Mucosal cuff shrinkage, following removal of the healing abutments, was measured in bucco-lingual direction at four time points – immediately after 20, 40 and 60 s. ANOVA was used to for statistical analysis. Eighty-seven patients (49 women and 38 men) with a total of 311 implants were evaluated (120 maxilla; 191 mandible; 291 posterior segments; 20 anterior segments). Two-hundred and five (66%) implants displayed thick and 106 (34%) thin gingival biotype. Time was the sole statistically significant parameter affecting mucosal cuff shrinkage around dental implants ($P < 0{\cdot}001$). From time 0 to 20, 40 and 60 s, the mean diameter changed from 4·1 to 4·07, 3·4 and 2·81 mm, respectively. The shrinkage was 1%, 17% and 31%, respectively. The gingival biotype had no statistically significant influence on mucosal cuff shrinkage ($P = 0{\cdot}672$). Time required replacing a healing abutment with a prosthetic element should be minimised (up to 20/40 s), to avoid pain, discomfort and misfit.**

KEYWORDS: mucosal cuff, shrinkage, dental implants

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Introduction

The structure of soft tissues surrounding endosseous implants is in many ways analogous to the natural tooth. A normal, gingiva-like tissue is frequently present around the transmucosal implant or abutment portion. This tissue consists of a dense, collagenous lamina propria, covered with a stratified, squamous, keratinising oral epithelium (1). However, there are substantial differences between the connective tissue structures surrounding teeth and implants (2–4). Hansson *et al.* (5) studied the interface zone between tissue and implants on humans. The peri-implant collagen fibre bundles arose from the neighbouring alveolar crest, root cementum of adjacent teeth or, superficially, from the epithelium and followed a circular array around the implant neck (6). Epithelial cells were observed to form a tight hemidesmosomes connecting collar around the titanium implant (5, 7, 8). Yet, the gingiva and the peri-implant mucosa still have many anatomical features in common (9–11).

No evidence was found to suggest that abutment exchange adversely affects implant survival (12). However, the exchange of the abutment after the healing phase disrupted the functional epithelium lining, with severance of the hemidesmosomal attach-

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ment, provoking a further period of healing (9, 10, 13, 14). The disruption of the soft tissue is thought to influence bone resorption around the implant. Such early bone resorption has been primarily linked to exposure of the implant to the oral environment and disconnection and reconnection of the abutment during the prosthetic phase (15–17).

The positioning of prosthetic implant components can also be a source of pain for patients (18). Furthermore, shrinkage of the mucosal cuff around dental implants can compromise the fit of prosthetic implant components (18).

The purpose of this study was to measure the dynamics of mucosal cuff shrinkage around dental implants following removal of the healing abutment.

Materials and methods

Individuals treated by skilled clinicians (prosthodontist/resident) with implant-supported fixed partial dentures, between 2004 and 2009, at the Oral Rehabilitation Department, School of Dentistry, Tel Aviv University, Tel Aviv, Israel, were included in the study. The Tel Aviv University institutional review board approved the study, and each patient signed an informed consent. Demographic data (age, gender), implants' location (mandible/maxilla, anterior/posterior), type, length, diameter and the dimensions of the healing abutments were recorded.

The gingival biotype was categorised as either thin (visible) or thick (not visible), according to the visibility of the underlying periodontal probe through the gingival tissue, at the midfacial aspect of the implant (19).

A large sample size was used (311 implants) to ensure the credibility of the results. For each of the implants, mucosal cuff shrinkage, in the bucco-lingual dimension, was measured immediately (0 s) following removal of the healing abutments and after 20, 40 and 60 s. Measurements were made with a calibrated manual periodontal probe (UNC 15*). Independent measurements were made by two skilled clinicians. Initial calibration was made for 50 implants. The inter-rater agreement was 96%. For the additional 4%, an average of the measurements was used.

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Data were collected in electronic charts and were statistically analysed using ANOVA with repeated measures at a significance level of $\alpha = 0{\cdot}05$.

Results

The study population consisted of 87 individuals (49 women and 38 men), (mean age 56·3 ± 11; range 19–74 years).

A total of 311 implants were included [120 maxilla; 191 mandible; 291 posterior segments (pre-molars and molars); 20 anterior segments (canine to central)]. Five brands were used: MIS (MIS†); 3I‡; Zimmer§; Implant Direct¶; and Nobel Biocare** with 163, 69, 46, 26 and 7 implants, respectively. Average implants' length was 11·9 ± 1·2 mm (range 8–16 mm) and diameter was 4·1 ± 0·4 mm (range 3·3–6 mm). Healing abutments' average height was 4·8 ± 0·7 mm (range 3–7 mm) and diameter was 4·1 ± 0·3 mm (range 3·7–5 mm). Implants' depth (from free gingivae to implant's collar) was recorded in four areas: buccal, mesial, lingual and distal. Average depths were as follows: buccal 2·7 ± 0·7 mm (range −1 to 5 mm), mesial 2·7 ± 0·9 mm (range −1 to 6 mm), lingual 2·3 ± 0·7 mm (range −1 to 7 mm) and distal 2·9 ± 0·7 mm (range −1 to 5 mm).

Assessment of gingival biotype using a periodontal probe resulted in 205 sites (66%) with thick and 106 sites (34%) with thin gingival biotype.

Time had a statistically significant influence on mucosal cuff shrinkage ($P < 0{\cdot}001$). At time 0, 20, 40 and 60 s, the mean diameter was 4·1 ± 0·30, 4·07 ± 0·3, 3·4 ± 0·58 and 2·81 ± 0·58 mm, respectively. The shrinkage was 1, 17, 31% and respectively (Figs 1 and 2).

Demographic, implant and gingival biotype parameters analysed failed to show any statistically significant influence on the mucosal cuff shrinkage with time (Figs 3 and 4).

Discussion

In the present study, time had a statistically significant influence on the mucosal cuff shrinkage around

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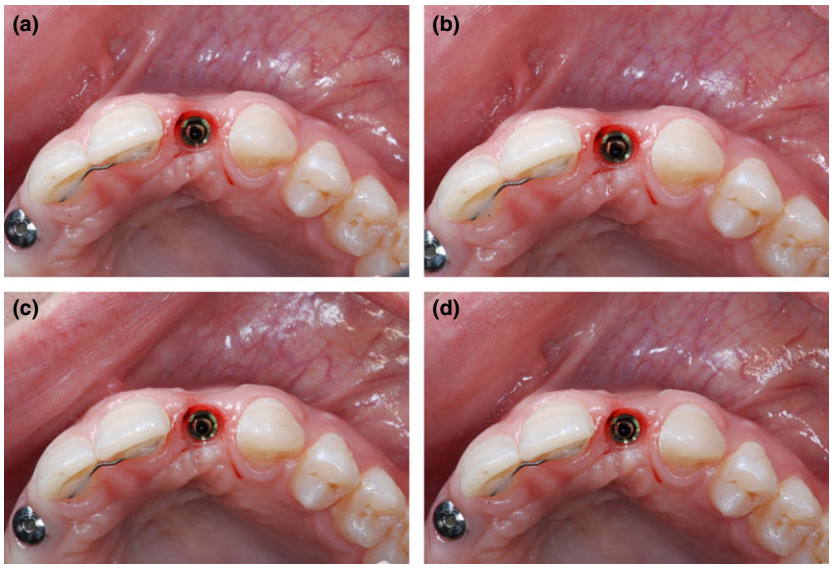

Fig. 1. Mucosal cuff shrinkage at the measured time points. 1a = time 0; 1b = time 20 s; 1c = time 40 s; and 1d = time 60 s.

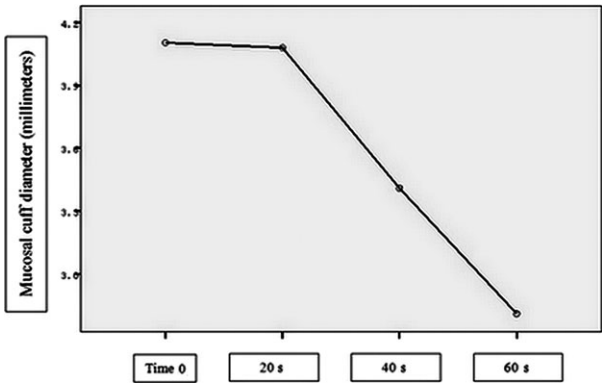

Fig. 2. Mean mucosal cuff shrinkage (mm) with time (s).

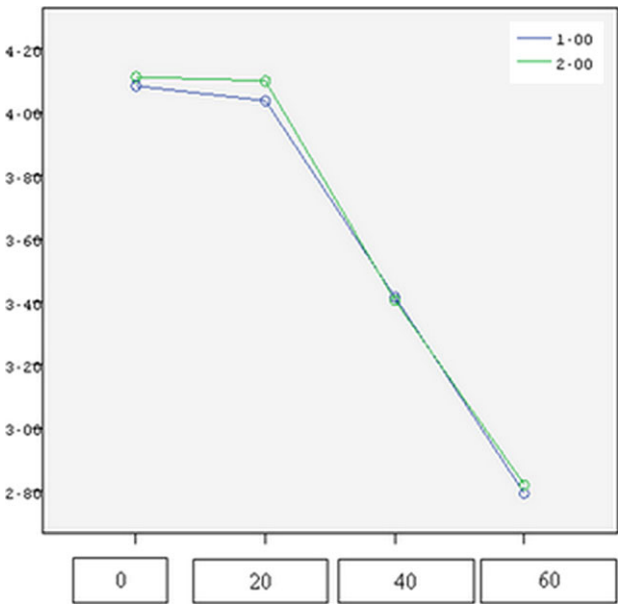

Fig. 3. The effect of gingival biotype (1 thin, 2 thick) on the mean mucosal cuff shrinkage (mm) along time (s).

dental implants ($P < 0{\cdot}001$) even after 60 s. The mean diameter became 2·81 mm, a significant shrinkage (31%) compared to time 0 ($P < 0{\cdot}001$). Many times, the actual time between removal of the healing abutment and connection of a transfer or a prosthetic element is much more than 60 s.

The assessment of gingival biotype incidence in the study group using a periodontal probe resulted in 66% with a thick gingival biotype and 34% with a thin gingival biotype. Such incidence is in agreement with the results reported by Kan *et al.* (19) (62·5% thick and 37·5% thin gingival biotype). We were surprised to notice that the gingival biotype had no statistically significant influence on mucosal cuff shrinkage along time ($P = 0{\cdot}672$).

Epithelial cells form a tight collar around the titanium implant. There are hemidesmosomes connecting the bordering epithelial cells to the titanium implants, and their presence seems to offer a firm attachment to the titanium surface. Due to the special connection between the epithelium, implant's neck and healing abutment, the definitive or temporary positioning of prosthetic implant components can be a source of pain for patients, especially, when the implant–abutment connection is situated bellow the free gingival margin (16, 17). Swelling of the peri-implant soft

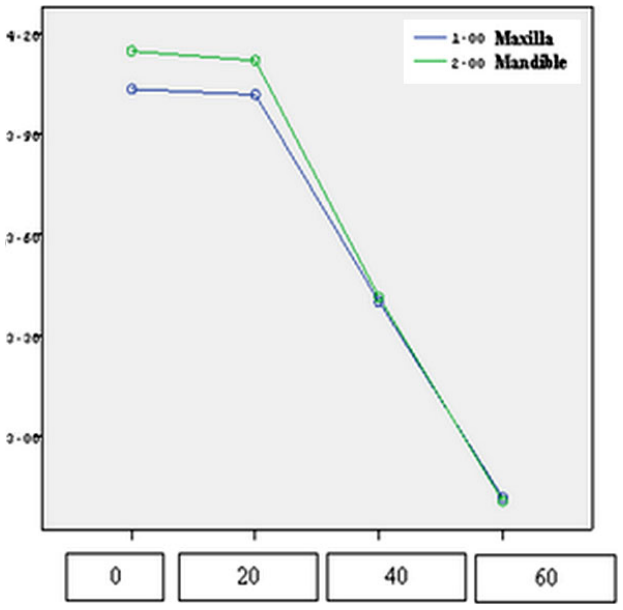

Fig. 4. The effect of implant location (1 maxilla, 2 mandible) on the mean mucosal cuff shrinkage (mm) along time (s).

tissues can compromise the fit of prosthetic implant components (16, 17). Furthermore, shrinkage of the mucosal cuff around dental implants can result in technical problems such as difficulty in implant–transfer connection for impressions, or implant–abutment connection.

No evidence was found to suggest that abutment exchange may adversely affect outcome of implant treatment (12). However, the exchange of the abutment after the healing phase may disrupt the functional epithelium lining of the cuff with severance of the hemidesmosomal attachment of the tissue on the titanium surface, provoking a further healing period (9, 10, 13, 14).

Future studies should explore whether quick replacement of the healing abutment can reduce the alveolar bone resorption over time.

Conclusion

Time required to replace a healing abutment with a prosthetic element should be minimised (up to 20/40 s) to avoid pain, discomfort and misfit.

Disclosure

The authors declare that they have no conflict of interest and no source of funding for the study. The study was approved by the institutional review board of the Tel Aviv University.

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