Regeneration of Gingival Papillae After Single-Implant Treatment

An index to assess the size of the interproximal gingival papillae adjacent to single implant restorations was described and preliminary tested in a pilot study of retrospective material comprising 25 crowns in 21 patients. The result indicated a significant spontaneous regeneration of papillae (P < .001) after a mean follow-up period of 1.5 years. Based on these results, the general conclusion was made that the proposed index allows scientific assessment of soft tissue contour adjacent to single-implant restorations. The results also indicated that soft tissue changed in a systematic manner during the time period between insertion of the crowns and follow-up 1 to 3 years later. (Int J Periodont Rest Dent 1997;17:327-333.)

The first single-crown restoration supported by Bränemark implants (Nobel Biocare) was placed in December 1982.1-3 The following years of development of the single-implant technique focused on mechanical and esthetic problems associated with the abutment components. Accordingly, the subgingival single-implant abutment technique was tested the following year,1 thereby presenting a technical solution for placement of the margin of the crown in a controlled relation to the soft tissue margin. More recent interest in the single-implant technique has focused on different surgical procedures for restoring the alveolar crest and managing the soft tissue contour adjacent to the restorations. Several techniques have described the design of the surgical flaps to minimize soft tissue recession and to allow optimal healing of the papillae.4-7 However, although the problem with inadequate papillae has been identified and extensively dis-
cussed, data is lacking on the frequency and extent of recession of papillae in routine single-implant treatment.

The objective of the present study was to propose an index to clinically evaluate the degree of recession and regeneration of papillae adjacent to single-implant restorations, and to test this proposed index in a pilot study for assessment of the soft tissue at the time of crown insertion and during follow-up.

**Method and materials**

*Retrospective group*

This report was designed as a retrospective study. Patients were identified according to the criteria that they had been treated with routine single-implant restorations and photographically documented at the time of crown insertion, and that photographs of the clinical result 1 to 3 years later were available.

Twenty-one patients with a mean follow-up time of 1.5 years (SD = 0.6 years) were found that fit the criteria. Nine of the patients were male, and the mean age of the group was 23.7 years (SD = 7.0 years) at the time of stage one surgery. The age ranged from 14 to 42 years.

Four patients received two single implants, and the remaining 17 patients received one implant each. Five of the crowns placed were central incisors, 13 were lateral incisors, three were canines, and four were premolars. Two of the premolars were placed in mandible, and the remaining 23 crowns were placed in maxilla.

Standard Brånemark implants were inserted following routine surgical protocol. After healing, all implants were provided with standard or healing abutments of various lengths. The top of the abutments were placed close to or above the soft tissue margin to allow proper healing of the soft tissue. After healing of the soft tissue, a final impression was made using the implant transfer coping (DCA 099, Nobel Biocare) or CeraOne (DCB 119, Nobel Biocare) technique. The permanent crowns were eventually cemented to a single-implant abutment by means of conventional zinc phosphate cement.

No special emphasis with regard to oral maintenance was given in connection to the placement of the artificial crowns, i.e., normal toothbrushing and possibly gentle proximal cleaning with dental floss was suggested.
Papilla contour measurements

An index of the contour of the proximal papillae was made for assessment of the photographs taken at placement of the single crowns and 1 to 3 years later.

The index designated five different levels indicating the amount of papilla present. The assessment was measured from a reference line through the highest gingival curvatures of the crown restoration on the buccal side and the adjacent permanent tooth. The distance from this line to the contact point of the natural tooth/crown was also assessed (Fig 1):

1. Index score 0: No papilla is present, and there is no indication of a curvature of the soft tissue contour adjacent to the single-implant restoration (Figs 2a and 2b).
2. Index score 1: Less than half of the height of the papilla is present. A convex curvature of the soft tissue contour adjacent to the single-implant crown and the adjacent tooth is observed (Figs 3a and 3b).
3. Index score 2: At least half of the height of the papilla is present, but not all the way up to the contact point between the teeth. Papilla is not completely in harmony with the adjacent papillae between the permanent teeth. Acceptable soft tissue contour is in harmony with adjacent teeth (Figs 4a and 4b).
4. Index score 3: The papilla fills up the entire proximal space and is in good harmony with the adjacent papillae. There is optimal soft tissue contour (Figs 5a and 5b).
5. Index score 4: The papillae are hyperplastic and cover too much of the single-implant restoration and/or the adjacent tooth. The soft tissue contour is more or less irregular (Figs 6a and 6b).

Other soft tissue assessments

Discoloration of the soft tissue above the restoration and visible titanium margins were identified as present or not present. Signs of severe inflammation or fistulas were also noted.

A comparison was made between the situation at the time of placement and at follow-up. The following assessments of the photographs were made: (1) The size of the papilla was determined and classified as having increased, remained the same, or been reduced during the follow-up period; and (2) a change of color of the soft tissue and/or a visible titanium margin was noted.
Fig 1. The index was based on the measurement of a reference line through the highest curvatures of the crown restoration on the buccal side and the adjacent permanent tooth. The distance from this line to the contact point of the teeth/crowns was also assessed, and half of the height of the papilla was recorded.

Fig 2. Index score 0—No papilla is present, and there is no indication of a curvature of the soft tissue contour adjacent to the single-implant restoration (left). Left lateral incisor with Papilla Index score of 0 (right).

Fig 3. Index score 1—Less than half of the height of the papilla is present. A convex curvature of the soft tissue contour adjacent to the single-implant crown and the adjacent tooth is observed (left). Right lateral incisor with a mesial Papilla Index score of 1 (right).

Consistency of measurements

Assessments of papillae contour were determined for the 25 crowns on two separate occasions with a time interval of 11 days. The mean difference between the two registrations of papillae contour index was 0.11 (SD = 0.53).

Statistical analysis

The sign test for paired comparisons was used to statistically test changes in the papilla contour index at placement and follow-up on the mesial and distal side of the single-implant restoration. A P value greater than .05 was not considered significant.

Results

The index scores of the papillae ranged from 0 to 3 at the time of placement and from 1 to 4 at the follow-up appointment. Distribution of the score of the index at placement and follow-up is presented in Table 1. The increase in size of the papillae was significant for both the mesial (P < .001) and distal sides (P < .001).
Fig 4  Index score 2—Half or more of the height of the papilla is present, but does not extend all the way up to the contact point between the teeth. The papilla is not completely in harmony with the adjacent papillae between the permanent teeth (left). Left central incisor with a distal papilla index score of 2 (right).

Fig 5  Index score 3—The papillae fill up the entire proximal space and are in good harmony with the adjacent papillae. Optimal soft tissue contour (left). Left mandibular first premolar with papilla index score of 3 (right).

Fig 6  Index score 4—The papillae are hyperplastic and covers too much of the single-implant restoration and/or the adjacent tooth. The soft tissue contour is more or less irregular (left). Right central incisor with a mesial papilla showing a minor hyperplasia with an index score of 4 (right).

The mean index for the size of the mesial and distal papillae at crown placement was 1.44 (SD = 0.94) and 1.52 (SD = 0.70), respectively. The corresponding mean values at follow-up were 2.48 (SD = 0.70) and 2.46 (SD = 0.72) for the mesial and distal sides, respectively. Ten percent of the papillae were judged to be in optimal harmony with the adjacent papillae (index score 3) at the time of insertion (Table 1). At the

| Table 1  Distribution of Papilla Index |
|-------|------|----|----|----|----|
|        | Papilla Index score | 0  | 1  | 2  | 3  | 4  |
| Mesial papillae |
| Placement | 5  | 7  | 10 | 3  | 0  |
| Follow-up  | 0  | 3  | 5  | 17 | 0  |
| Distal papillae |
| Placement | 1  | 12 | 10 | 2  | 0  |
| Follow-up  | 1  | 1  | 10 | 12 | 1  |

A significant increase of the papillae was found on both the mesial (P < .001) and distal (P < .001) sides.
time of follow-up, 29 papillae (58%) had recovered completely (Table 1).

When the photographs were compared simultaneously, the size of the papilla was considered to have increased in 40 sites in the follow-up photographs. The remaining 10 papillae were considered to be of the same size.

For four crowns, the soft tissue had become more dark/grey above the restorations. Furthermore, in two crowns soft tissue recession had occurred to the level that the titanium margin of the abutment was exposed, while in another two cases tissue recession was obvious, but no metal was visible. No fistulas or loose crown restorations were noted in this study.

Discussion

The results of the present study clearly indicate that papillae adjacent to single-implant restorations regenerate to some extent after 1 to 3 years without any clinical manipulation of the soft tissue. The reason for this spontaneous recovery of papillae is unclear, but it may be suggested that plaque accumulation in the proximal areas creates inflammation and subsequent swelling of the soft tissue analogous with findings reported by Jemt et al.9 in maxillary overdenture situations. Thus, in time the hyperplastic, inflamed tissue would mature and reorganize into papillae. If this is the case, optimal cleaning procedures with dental floss and interproximal brushes immediately after insertion of single-implant restorations would counteract a regeneration of the soft tissue contour and would thereby compromise the long-term esthetic result of the treatment!

Of course it is natural to aim for a surgical and restorative procedure that allows for optimal health of the hard and soft tissue surrounding the implant restoration. Accordingly, the Brånemark system was developed following a very strict surgical procedure with regard to tissue health. However, when the soft tissue was allowed to heal after the second surgery,2 an obvious recession of the proximal soft tissue seemed to occur, and only a few situations presented in this material had optimal papilla contour at the time of crown placement (see Table 1, index score 3). It is in light of these findings that different surgical techniques to optimize the soft tissue contour should be discussed.4-7 Many of the proposed surgical techniques have indicated good early esthetic results in single clinical cases, but the predictability of these results in a consecutive series of cases and the absence of clinical controls call for more scientific research in this field. The present index was designed to propose a simple technique to evaluate the degree of recession and regeneration of the soft tissue in the proximal areas.

On average, about half of the height of the papilla was lost (mean index 1.5; Table 2) in the present group when the soft tissue was allowed to heal completely around the temporary abutment prior to crown fabrication. However, after 1 to 3 years, a spontaneous regeneration was observed, and a majority of the papillae (58%) were completely recovered and in harmony with the adjacent natural teeth (see Table 1). This esthetic situation has been demonstrated in randomly selected clinical cases; however, it is not possible to evaluate when the regeneration was achieved in the present cases. A conservative surgical technique that aims to maintain the soft tissue contour would probably allow a better result at the time of insertion, but in long-term assessment, a spontaneous adaptation of the soft tissue would probably compensate for some of the achieved defects. A better knowledge of the clinical situations in which this spontaneous healing will occur would be advantageous.
In addition to regeneration of the papillae, other changes in the soft tissue adjacent to the single-implant restorations were observed. A tendency of recession was indicated in association with some crowns; in two patients the soft tissue recession was such that the titanium cylinder was exposed. It is not clear whether these exposures occurred because the abutment cylinders that were chosen were too long, or because of other reasons, such as incorrect tooth-brushing technique. However, the changes in the topography of the soft tissue adjacent to single-implant restorations in the present study clearly indicate that the soft tissue contours at the time of crown insertion should not be expected to remain unchanged. On the contrary, a dynamic adaptation and change of tissue topography must be anticipated during the follow-up period. Based on these results, the general conclusions can be made that the proposed index allows a scientific assessment of soft tissue contour adjacent to single-implant restorations and that soft tissue seems to change in a systematic way from insertion of the crowns to follow-up 1 to 3 years later.

Acknowledgments

The author would like to acknowledge Dr. P. Milleding for his help with the figures.

References