Comparison of papilla healing following sulcular full-thickness flap and papilla base flap in endodontic surgery

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Abstract

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Aim To compare the loss of papilla height when using the papilla base incision (PBI) or the standard papilla mobilization incision in marginal full-thickness flap in cases with no evidence of marginal periodontitis.

Methodology Twelve healthy patients referred for surgical treatment of persisting apical periodontitis, who were free from periodontal disease and had intact interdental papillae, were included in the study. The preoperative papilla height was recorded by measuring the distance between a reproducible coronal point on the tooth and the most coronal point of the papilla. The flap design consisted of two releasing incisions connected by a horizontal incision. The marginal incision involved the complete mobilization of the entire papilla in one interproximal space, and the PBI in the other interproximal space. The PBI consisted of a shallow first incision at the base of the papilla and a second incision directed to the crestal bone creating a split thickness flap in the area of the papilla base. Further, apically, a full-thickness flap was raised. In the other interproximal space, the buccal papilla was carefully incised and elevated completely. Following flap retraction, standard root-end resection and root-end filling were performed. Flap closure was achieved with microsurgical sutures. The PBI was sutured with two to three interrupted sutures (size 7/0) and the elevated papilla was reapproximated with vertical mattress sutures, which were removed 3–5 days after the surgery. The height of the interdental papilla was evaluated preoperatively and postoperatively after 1 month and at the 3-month recall, using plaster replicas. The loss of papilla height was measured using a laser scanner. Twelve papilla-paired sites were evaluated. The results were statistically analysed using the *t*-test.

Results Complete closure of the wound was achieved in all treated sites followed by uneventful healing in all patients. The total mobilization of the papilla resulted in loss of papilla height of 1.10 ± 0.71 mm at 1 month and 1.25 ± 0.81 mm at the 3-month recall. At the 3-month recall, the retraction had increased in nine sites, whereas in three sites, the loss of height had slightly diminished compared to 1 month. In contrast, after the PBI, only minor changes could be detected: 0.07 ± 0.09 mm at 1 month and 0.10 ± 0.15 mm at 3 months. There was a significant difference between the two incision techniques studied ($P < 0.007$).

Conclusions In patients with healthy marginal periodontal conditions, the PBI allows rapid and predictable recession-free healing, whereas complete mobilization of the papilla led to a marked loss of the papilla height. In aesthetically relevant areas, the use of the PBI is recommended, to avoid opening of the interproximal space, when periradicular surgical treatment is necessary.

Keywords: apical surgery, flap design, papilla base incision, papilla healing, recession, sulcular incision.

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Introduction

Endodontic failures not responding to conventional root-canal treatment require surgical treatment (Friedman & Stabholz 1986). Endodontic surgery involves exposure of the bone covering the root(s) and the apices. To achieve access, a full-thickness flap should be raised, consisting of gingival and mucosal tissue as well as periosteum. To mobilize the flap, various types of incisions can be selected, including horizontal incisions (sulcular and submarginal) and vertical releasing incisions (Gutmann & Harrison 1991).

Although microsurgical techniques have been applied in endodontic surgery for several years, little attention has been given to soft tissue healing following treatment. There is also limited scientific and clinical data on recession of soft tissues during healing, specifically papilla healing, when no pathological changes are present in the periodontal tissues. The care of healthy periodontal tissues is challenging and is of importance to prevent attachment loss and recession of the gingiva following endodontic surgery. Loss of the interproximal dental papillae may cause functional, phonetic and aesthetic problems. Complete and predictable restoration of lost interdental papillae remains one of the greatest challenges in periodontal reconstructive surgery (Blatz *et al.* 1999). It is imperative therefore to maintain the integrity of the papilla during restorative and surgical procedures.

The presence or absence of the interdental papilla depends upon the distance between the contact point and the crest of bone (Tarnow *et al.* 1992). When the distance between the contact point and the bone was 5 mm or less, the papilla was present almost 100% of the time. With a distance of 6 mm, the papilla was present 56% of the time, and when the distance measured 7 mm or more, the papilla was present 27% of the time or less.

In periapical surgery, the sulcular full-thickness flap is often used (Beer *et al.* 2000). The main disadvantage of the sulcular full-thickness flap is recession and, especially, unpredictable shrinkage of the papilla during healing (Zimmermann *et al.* 2001), although Chindia & Valderhaug (1995) found no difference in attachment loss between trapezoidal and semilunar flaps in apicectomy. A persisting endodontic infection following periradicular surgery may also be regarded as a contributing risk factor for progressing marginal attachment loss (Jansson *et al.* 1997). The mean clinical attachment loss in teeth with unsuccessful periapical healing was 0.85 mm, and it differed significantly from successfully healed cases with a mean of 0.15 mm.

To prevent marginal recession of the gingiva, a submarginal incision was suggested (Luebke 1974). This incision is made within the attached gingiva parallel to the marginal contour of the gingiva. The submarginal flap is advocated, when there is a broad band of attached gingiva and the expected apical lesion or surgical bony access will not extend to the incision line. This flap design preserves the marginal gingiva and does not expose the crestal bone. In maxillary anterior areas, the submarginal incision is preferred in situations with subgingivally placed margin of crowns and bridgework. The main disadvantage of the submarginal incision is scar formation because of flap shrinkage (Kramper *et al.* 1984).

The papilla base incision (PBI) for the marginal mucoperiosteal flap was suggested to prevent loss of interdental papilla height (Velvart 2002). This incision allows the preservation of the entire papilla, thus eliminating any substantial loss of height as a result of the surgical or healing process. The PBI consists of a shallow first incision at the base of the papilla and a second incision directed to the crestal bone creating a split thickness flap in the area of the papilla base. Further, apically, a full-thickness flap is raised. The change in distance between a reference point and the most coronal point of the papilla comparing the preoperative and the 1 month postoperative situations, using the PBI, was 0.05 ± 0.39 mm.

The purpose of the study was to compare the loss of papilla height, when the PBI or standard papilla elevation in sulcular full-thickness flap was used, in cases with no evidence of marginal periodontitis.

Materials and methods

Twelve patients (six women and six men) in good general health referred for surgical treatment of persistent apical periodontitis were included in the study. The age of the patients ranged between 36 and 63 years with a mean age of 45 ± 9.4 years. The teeth consisted of mandibular and maxillary anterior, premolar and molar teeth (Table 1). All teeth had previously been root filled at various times and with different methods, but all were failing with persisting symptoms and/or apical

Table 1 Frequency distribution of treated teeth according to tooth type

	Maxillary	Mandibular
Anteriors	6	0
Premolars	3	1
Molars	0	3

radiolucency. A conventional retreatment had either been performed and failed, or was not feasible because of canal obstruction, or the patient refused to sacrifice the coronal restoration for retreatment. Only patients without signs of periodontal disease were included in the study. Periodontal health was defined as absence of bleeding on probing, and probing depths not exceeding 3 mm on any of the teeth in the area of the surgery. Interdental papillae were occupying the interproximal space below the contact area.

All teeth were anaesthetized with 4% articaine with 1 : 100 000 epinephrine infiltration, and in the designated flap area, additional lidocaine with 1 : 50 000 epinephrine was administered for profound haemostasis. A mandibular block together with infiltration anaesthesia was given for the mandibular teeth, and for maxillary teeth, only infiltration anaesthesia was applied. The entire surgical procedure was performed with microsurgical instruments and magnified vision of at least 4.3× using loupes and an operating microscope.

The flaps consisted of two releasing vertical incisions and a horizontal incision in the following way. Initially, the vertical incisions were placed at least one tooth distally and mesially to the tooth to be treated, using a 15C blade (HuFriedy, Leimen, Germany). Depending on the tooth location, at least two interproximal spaces were included in the flap between the vertical incisions (Fig. 1). When the mental nerve was part of the flap, the releasing incisions were placed at least one tooth mesially or distally, to avoid damage to this vital structure, resulting in three or four interproximal spaces. The experimental sites were always the mesial and distal papillae of the tooth with the apical pathology to be treated. The horizontal incision involved in one interproximal space is the standard complete mobilization of the entire papilla, and in the other interproximal space, the PBI. The marginal incision started with the preparation of the PBI. The PBI required two different incisions at the base of the papilla, as described by Velvart (2002). The standard papilla incision to free the buccal from the lingual papilla was performed with microscalpel blade (BB 369, Aesculap, Tuttlingen, Germany). The scalpel blade was placed in the sulcus and moved towards the tip of the papilla. Care was taken to preserve the dimensions of the papilla during the procedure. Buccally over the tooth, the interproximal spaces were joined by an intrasulcular incision. The scalpel was moved within the sulcus, dissecting the gingiva to the crestal bone. The sulcular incision reached from the releasing incision to the start of the PBI, or from one papilla to the next. The incision technique applied to the mesial or distal interproximal space was randomly selected. The flap was mobilized and retracted during the root-end resection and filling.

Figure 1 Clinical photograph of the flap. The lateral incisor was surgically treated. In the mesial interproximal space, the PBI was performed, whereas in the distal interdental area, complete mobilization of the papilla took place.

The flap closure was initiated from the releasing incisions. For the vertical incisions, 6/0 (Supramid, B. Braun, Neuhausen, Switzerland) interrupted polyamide sutures were used. The PBI was sutured with two or three polypropylene 7/0 (Prolene, Ethicon, Norderstedt, Germany) interrupted sutures depending on the width of the papilla. Great care was taken in passive reapproximation and perfect adaptation of the wound margins without tension to the sutures. The mobilized papilla was adapted with a vertical mattress suture. The flap was compressed for 1 min at the conclusion of the surgery. Patients were instructed to apply a cold compress to the face for 10 min every 30 min for the rest of the day, and were prescribed NSAID (Ponstan, Parke Davis, Baar, Switzerland), 250 mg thrice per day for 48 h. Following this, patients only took the analgesics when required. Patients were instructed to refrain from mechanical oral hygiene in the operated area and rinse twice daily with 0.2% chlorhexidine during first week after the surgery. The sutures were removed 3–5 days postoperatively. The patients were further evaluated at 1 and 3 months postoperatively (Fig. 2a–d).

In each surgical site, alginate impressions were taken before the surgery and 1 and 3 months postoperatively. Twelve papilla pair areas – mesial and distal – of the endodontically involved tooth were studied. The interproximal spaces were analysed in the following way.

The plaster casts were analysed using the Laserscan 3D device (Willytec GmbH, Munich, Germany). The Laserscan 3D is a measuring device with a laser light source and a light-sectioning sensor, which allows contact-free scanning of objects in 2–5 axes. It was

Figure 2 Clinical view of first mandibular premolar treated. (a) Preoperative situation; (b) postsurgery; (c) healing at 1 month; (d) recall at 3 months. Note the marked recession of the distal papilla, which was completely mobilized in the flap.

equipped with a driving table and a vice to fix the object to be scanned. The scanner was connected to a PC (Willytec GmbH, Munich, Germany). Scanning data were registered using the Linux Scan 3D software module (Willytec GmbH, Munich, Germany), which controlled the hardware of the laser scanner. Scan 3D registered the incoming signals and saved the resulting 3D measured points in a file. The further analysis and evaluation of the data took place in the Match 3D program (Linux,Willytec GmbH, Munich, Germany). Before starting the scanning procedure, the axis of the driving table was calibrated. Then the plaster model was fixed in the vice using sculpting clay. The object was positioned in the designated measuring field using a joystick. The alignment was set as follows:

1. *x*-axis (right/left) of the laser beam in the middle of the surface to be evaluated,
2. *y*-axis (forward/backward) in the plane of the optic, and
3. *z*-axis (up/down) in the middle of the object to be analysed.

To perform a measurement, the scan parameters 'number of steps', 'step distance' and '*x*-pixel increment' were adjusted. In the present study, the adjustments made were: number of steps: 400; step distance: 90 μm; and *x*-pixel increment: three. The '*x*-pixel increment' corresponds to the variable 'step-distance value' and was a multiple of the set-reference value of 30 μm (= resolution of the camera chip). This resulted in 400 measurements (slices) × 90 μm distance between measurements, which summed up to 36 mm total length of the plaster cast surface.

The 'step distance' only affected the distance between steps in the *x*-direction, whilst the settings in the *y*-direction were of 30 μm, and could not be altered as they were determined by the distance between the pixels on the camera chip and by the magnification of the lens system.

Using a step distance of 90 μm in the *x*-axis, an asymmetrical image would have resulted on the monitor. Therefore, an *x*-pixel increment of three had to be chosen to compensate for the fact that there were thrice as many points in the *y*-direction as in the *x*-direction.

Evaluation of the data was carried out using the Match 3D software. After opening a file, the results of the scanning appeared on the screen as a photo-realistic depiction. The steeper the surface between two points, the darker these appeared on the screen. This shadowing between peaks produced the image. For each patient, all recorded files were opened and a reproducible point on each of the casts was chosen. The distance from this reproducible point to the highest point of the papilla was measured for each cast. These distances were placed in relation to each other to evaluate vertical changes of papilla height. The data were statistically analysed using the pairwise *t*-test.

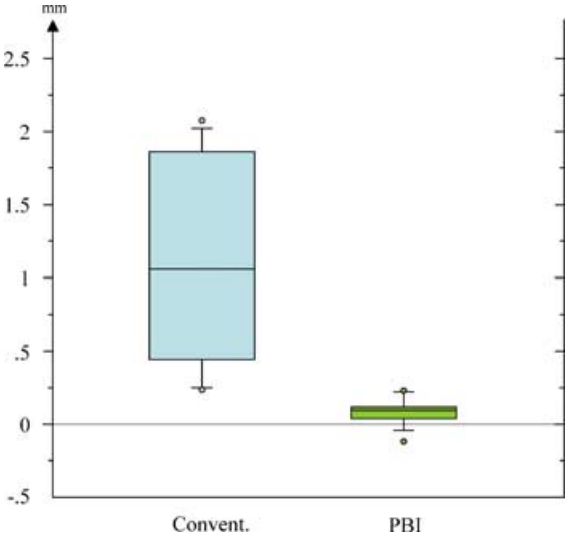

Figure 3 Loss of papilla height after 1 month compared to the preoperative level.

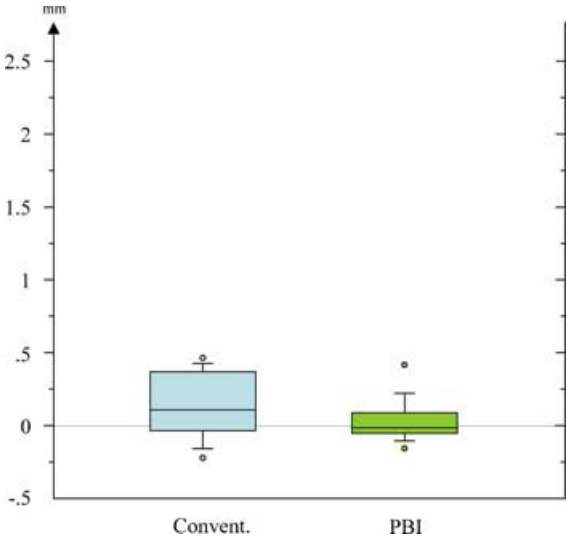

Figure 5 Loss of papilla height between 1 and 3 months.

Results

All patients displayed uneventful healing at 1 month. The loss of papilla height is shown in Figs 3–5. The mean recession for the PBI measured between a reference point and the most coronal point of the papilla comparing the preoperative and the recall at 1 month was 0.07 ± 0.09 mm and at 3 months, 0.10 ± 0.15 mm. For the total mobilization of the papilla, the readings were 1.10 ± 0.72 mm at 1 month and 1.25 ± 0.81 mm at 3 months. The PBI incision showed significantly less shrinkage than total mobilization of the papilla (Fig. 3, $P < 0.007$) after 1 month and also after 3 months (Fig. 4, $P < 0.007$) compared with the preoperative levels. The changes between 1 and 3 months were much smaller and did not differ significantly (Fig. 5, $P < 0.24$). In complete papilla mobilization at 3-month recall, the retraction had increased in nine sites, whereas in three sites, the loss of height had slightly diminished compared to 1 month. The mean vertical changes between 1 and 3 months were 0.03 ± 0.17 mm for the PBI and 0.15 ± 0.23 mm for the papilla mobilization.

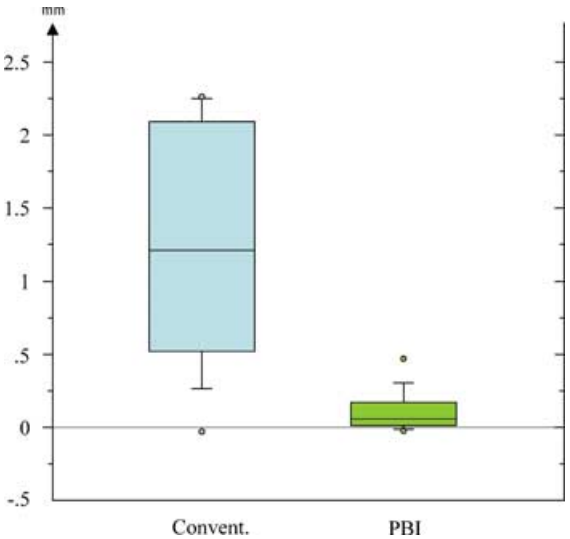

Figure 4 Loss of papilla height after 3 months compared to the preoperative level.

Discussion

It is important to preserve epithelial and connective tissue attachment at its original level and minimize trauma to the attachment apparatus during the surgical procedure in order to maintain the attachment level. Healing following sulcular marginal incision may lead to varying amounts of recession. Based on the results of this study, the total elevation of the papilla, generally used in sulcular flaps, results in a recession of 1.10 ± 0.72 mm at 1 month and 1.25 ± 0.81 mm at 3 months. In studies by Zimmerman *et al.* (2001, 2002), in spite of microsurgical techniques used, the mobilization of the papilla resulted in progressive loss of papilla height. It seems that the damage to the papilla during complete elevation occurs despite the use of less traumatic modern techniques (Fig. 2). Complete elevation of the papilla is technically difficult, especially in narrow interproximal spaces. Frequently, the most coronal portion of the papilla is

separated from the body of the papilla and left behind. These tissue fragments are often too small to survive and may necrotize during healing, resulting in loss of height. It also seems that in completely mobilized papillae, which are thin, narrow and high, the blood supply might not be sufficient, and consequently the most coronal portion of the tissue also necrotizes. However, the degree of loss of papilla height in correlation to its dimensions was not studied in this investigation.

The vertical mattress suture does not allow predictably the conventional papilla in the most coronal portion to sit closely to the underlying tissues, and this might predispose to recession with this design.

The main vertical loss of height occurs during the initial healing phase in the first month following the surgical procedure. After 4 weeks, only minor vertical change took place; in nine sites, increases in recession were observed, whereas in three sites, a small gain of the papilla height occurred, compared to the 1-month situation.

Tarnow *et al.* (1992) has shown that papilla height depends upon the distance between the contact point and the crest of bone. When the distance between contact point and crestal bone was 5 mm or less, the papilla was present at all times. Further, long-term observations should determine whether the lost papilla height would be restored through remodelling and creeping process, if the papilla was present preoperatively. Creeping was first described by Goldman *et al.* (1964) as a postoperative migration of the gingival marginal tissue in a coronal direction, covering partially or completely a previously denuded root. Creeping attachment has occurred after free gingival grafts (Matter 1980, 1982), pedicle grafts (Caffesse & Guinard 1980) and connective tissue graft procedures (Harris 1997). Creeping attachment occurred between 1 month and 1 year after surgery (Matter 1980, Harris 1997), whereas between 1 and 5 years, there were no significant differences between the values (Matter 1980).

In contrast to full mobilization of the papilla, the PBI resulted in 0.07 ± 0.09 mm of recession at 1 month and 0.10 ± 0.15 mm at 3 months. This is significantly less ($P < 0.007$) than the vertical loss of the papilla after total elevation of the interproximal tissue. The alteration of the marginal incision technique, leaving the body of the papilla in place, has practically eliminated any visible opening of the interproximal space. The PBI, consisting of two incisions at the base of the papilla, does not disrupt the blood supply to the interproximal tissue. The blood vessels to the buccal papilla are derived from the crestal bone, periodontal ligament and from anastomosing vessels from the lingual papilla (Schroeder 1979). The difficulty of the PBI is to avoid thinning out of the split flap. The epithelium of the partial thickness flap has to be supported by underlying connective tissue, otherwise it will necrotize and lead to scar formation. On the other hand, excessive thickness of the connective tissue layer of the split flap portion could compromise the survival of the buccal papilla left in place. The ideal thickness of the partial-thickness flap has not been studied. The epithelium thickness varies between 111 and 619 μm with a mean of 364 μm (Soehren *et al.* 1973). The recommended thickness of free gingival grafts was reported to be 1–2 mm (Mormann *et al.* 1981, Wennström & Pini Prato 1998). Based on gingival graft studies, a thickness of 1–1.5 mm was chosen for the split flap in the PBI. The selected thickness resulted in excellent healing patterns.

The healing pattern of the PBI at 1 month, as studied in a previous investigation, was either invisible or slightly visible for the majority of the sites (Velvart 2002). This is of importance when an endodontic surgical intervention is necessary in the anterior region. In aesthetically relevant areas, the PBI should be used to avoid opening of the interproximal space following marginal surgical exposure of the gingiva.

Conclusion

The present study has shown that the marginal incision has an effect on the degree of papillary recession. The PBI preserved the dimensions and papilla height during surgery and allowed predictable and almost recession-free healing. In contrast, the classical complete mobilization of the papilla to raise a full-thickness flap resulted in papilla recession, creating an interproximal open space. Long-term healing after 1 year will be studied.

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