A comparison of the scalloped and linear incisions as used in the reverse bevel technique

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Abstract. Using a split-mouth technique in 20 patients, a comparison was made of the linear and scalloped incisions as used in the reverse bevel technique. Forty full-thickness periodontal flap procedures were evaluated. The PI and GI were recorded and gingival fluid collected at operation and at weeks 1, 2, 3, 4 and 12 after operation. Pocket depths and attachment levels were noted and gingival contour assessed, using the Contour Index, pre-operatively and 12 weeks after operation. Pain experience during the first week after operation was evaluated. No significant changes in PI occurred throughout the study. The GI and gingival fluid flow showed comparable trends. More inflammation was present after the linear incision during the first 2 weeks after operation. Clinically, satisfactory results were achieved for both scalloped and linear incision procedures as shown by the improvement in gingival contour, reduction in pocket depth, slight gain in attachment, lack of gingivitis and low plaque scores.

The flap operation as a surgical means of eliminating periodontal pockets and allowing correction of osseous and mucogingival defects, has been used for many years. In order to conserve attached gingivae, yet still eliminate the pockets, wide use is now made of the reverse (inverse) bevel procedure, whereby only the inner aspect of the pocket is removed. The principle of the reverse bevel incision was thought to have arisen early in the nineteen hundreds; however, the person who actually introduced it is not really known. Credit has been given to Neumann (1912), Cieszynski (1914) and also to Widman (1917).

When utilising reverse bevel procedures, both scalloped and linear incisions have been described. The scalloped incision is such that it follows the contours of the gingival margin at varying distances from the margin depending on how much tissue is to be removed. After the flap is reflected and the surgical corrective procedures completed, the flap is usually replaced or repositioned so that the marginal soft tissue covers the marginal and interdental bone and hence minimizes the healing by secondary intention. The linear incision does not follow the contours of the gingival margin and hence does not provide any interdental soft tissue coverage for bone when the flap is replaced or repositioned, and therefore osse-
ous tissue is left exposed interdentally and healing in these areas is by secondary intention only.

Kirkland (1936) considered that the use of the scalloped flaps improved aesthetics in the immediate post-operative period, but there was no long-term benefit.

Friedman (1962) first described the use of a linear incision to create the inverse bevel for his flaps, but stated that when a scalloped incision was used the replaced tissue covered the interdental bone resulting in more rapid healing.

Pritchard (1972) employed the scalloped incision on the vestibular aspect of both arches and the lingual surface of the lower arch. However, on the palatal aspect he described the removal of the marginal tissue after using a horizontal linear incision. Then, after removal of the marginal tissue, the thick palatal flap was thinned after being reflected. When the thinned flap was sutured in place, the marginal bone was covered but the interdental area left to fill in by secondary intention. Pritchard feels that when a scalloped incision is used, especially on the palatal aspect, there is a resultant poor gingival form which often needs a second surgical procedure such as a gingvoplasty to correct it. He believes that although the scalloped incision provides faster healing, the end results may be a deeper gingival crevice than with the healed linear incision.

Because there appeared to be no documented clinical experiments which compared the use of linear and scalloped incisions in reverse bevel techniques, it seemed pertinent to evaluate their use in a flap procedure, particularly with regard to pocket elimination, rate of healing and gingival contour produced.

Materials and Methods

Subjects were selected from patients attending the periodontal clinic at the Royal Dental Hospital of London. Only patients needing periodontal surgery on each side of one or both jaws were considered.

The criteria for selection were as follows:

(a) the area involved was from the first bicuspid to the second molar;
(b) symmetry with regard to tooth alignment, hard and soft tissue deformities and pocket depths on both left and right sides of the arch involved;
(c) proximal contacts between all teeth in the areas involved;
(d) pockets not greater than 6 mm in depth immediately prior to surgery;
(e) radiographic evidence of horizontal bone loss, i.e., patients with macro-or vertical bone defects were excluded;
(f) absence of any systemic disease.

Pre-operative therapy, which varied in time from patient to patient, consisted of scaling, polishing and oral hygiene instruction. At each visit during the initial preparation phase of treatment, patients were disclosed with a 5% erythrosin solution.

The initial preparation phase was complete when the patients showed a high degree of plaque control.

Immediate pre-operative procedures. Prior to obtaining local anaesthesia, crevicular fluid was collected, gingival and plaque indices noted and pocket depth and loss of attachment measured. Alginate impressions were obtained and study models produced.

Crevicular fluid. This was collected on filter paper strips (Whatman's grade 4) measuring 1.5 mm wide and 15 mm long. Samplings at the mesio-buccal line angles, were performed according to the method of Loe & Holm-Pederson (1965). After 3 min the strips were removed, air dried and stained with a ninhydrin solution (0.5% ninhydrin in acetic acid).

The length of the stain was recorded at the centre of the条 at 1 mm using a calliper, a scale, units were obtained at the lingual, disto-buccal and bucco-lingual aspect of each tooth. The measurement was calculated.

Crevicular fluid analysis was according to the Crevicular Fluid Index (CFI) of Loe (1971). Each gingival unit was divided into three segments.

Pocket depth and area.

Pocket depths were measured using 5% erythrosin disclosing solution, blebs were classified as being a) full, b) partial and c) none.

Pocket depth measurements were taken at the mesio-buccal line angles of each tooth. The measurements were recorded on a chart.
The length of the stained area was measured in the centre of the strip to the nearest 0.1 mm using a calibrated magnifying glass, a scaleometer. The mean of all measurements in a segment was considered to be the exudate value of the segment.

**Plaque Index.** The amount of plaque present was measured using the Plaque Index (PI) of Silness & Löe (1964). Measurements were obtained at the mesio-buccal, mid-lingual, disto-lingual and mid-buccal aspects of each tooth. The mean surface score per segment was calculated.

**Gingival Index.** The gingival state was scored according to the criteria of the Gingival Index (GI) of Löe & Silness (1963), scoring each gingival unit, i.e. mesio-buccal, mid-lingual, disto-lingual and mid-buccal aspects. As with the Plaque Index, a mean unit score per segment was calculated.

**Pocket depth and attachment levels.** Pocket depths were measured with a graduated Williams periodontal probe at the mesio-buccal, mid-lingual, disto-lingual and mid-buccal aspects. The mean depth per segment was calculated by dividing the total measurements per segment by the number of aspects at which pocket depths were measured.

Using a graduated Cross calculus probe (Knight & Wade 1972), the position of the crest of the gingival margin relative to the cemento-enamel junction was measured. By subtracting this measurement from the pocket depth measurement the loss of periodontal attachment was calculated. Mean figures were calculated for the pocket measurements.

**Contour Index.** Tissue contour was assessed from the study models using the Index of MacLeod et al. (1965) as modified by Zimet (1967). Measurements were made from both the facial and lingual aspects.

Crevicular fluid. Plaque Index and Gingival Index were also assessed at 1, 2, 3, 4 and 12 weeks after operation. Measurements of pockets and loss of attachment were repeated 12 weeks after operation.

**Operative techniques.** Using a "split-mouth" technique both posterior segments of an arch were treated at one appointment using 2% lignocaine hydrochloride anaesthetic solution with 1:80,000 adrenaline.

Full thickness mucoperiosteal flap and curette procedures were performed on the buccal and lingual aspects using the reverse bevel technique. On one side of the arch a linear incision was used on the buccal and lingual and on the other, a scalloped incision. The choice of sides was randomized.

The incisions started 1–2 mm from the gingival margin and were carried down to the alveolar bone and angled to produce as thin a flap as possible. After elevation of the flap, the remaining collar of gingival tissue was removed from the necks of the teeth, granulation tissue curedt away and the root surface planed. Minor osteoplasty using round steel burs with sterile saline irrigation was performed where necessary. The flaps were then replaced to just cover the alveolar crestal bone and sutured with interrupted interdentinal silk sutures (Ethicon® 3/0).

After completion of one segment, the segment on the other side of the jaw was operated on. Alternation as to which side was operated on first was practised between left and right.

A Coespak® periodontal dressing was placed over the wounds. No antibiotics were prescribed. After 1 week the dressings were removed, crevicular fluid samples taken, the sutures removed. Patients were questioned about pain experienced and this rated as mild or severe. They were also asked whether it varied from side to side.

Data was analysed and levels of statistical
The difference between the two segments was not significant.

**Plaque Index.** The mean Plaque Indices for both segments before and after the flap procedures are shown in Table 3. Evaluation of the Plaque Indices showed that there was no great fluctuation during the 12 weeks after operation. There were no significant differences in PI between the scalloped and linear segments.

<table>
<thead>
<tr>
<th>Pocket depth</th>
<th>Interdental pocket depth</th>
<th>Radiolar packet depth</th>
<th>Loss of attachment</th>
<th>Interdental loss of attachment</th>
<th>Radiolar loss of attachment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pre-operative</strong></td>
<td></td>
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<tr>
<td>Mean</td>
<td>3.46</td>
<td>2.77</td>
<td>1.55</td>
<td>1.43</td>
<td>1.29</td>
</tr>
<tr>
<td>Diff.</td>
<td>0.04</td>
<td>0.10</td>
<td>0.13</td>
<td>0.09</td>
<td>0.07</td>
</tr>
<tr>
<td>S.E.</td>
<td>0.05</td>
<td>0.07</td>
<td>0.07</td>
<td>0.06</td>
<td>0.05</td>
</tr>
<tr>
<td><strong>Post-operative (12 weeks)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Mean</td>
<td>1.30</td>
<td>1.04</td>
<td>0.63</td>
<td>0.52</td>
<td>0.43</td>
</tr>
<tr>
<td>Diff.</td>
<td>0.26</td>
<td>0.42</td>
<td>0.23</td>
<td>0.12</td>
<td>0.08</td>
</tr>
<tr>
<td>S.E.</td>
<td>0.17</td>
<td>0.42</td>
<td>0.07</td>
<td>0.02</td>
<td>0.05</td>
</tr>
<tr>
<td><strong>T</strong></td>
<td>1.34</td>
<td>0.98</td>
<td>0.19</td>
<td>1.00</td>
<td>1.17</td>
</tr>
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</table>

There was no significant difference in PI between the scalloped and linear segments. There was a marked improvement for both procedures, which was statistically significant.

Pain experience. The pain was slight in the first 48 hours in the 16 patient, but the pain was of the mouth for both procedures. The pain was moderate in the mouth for both procedures.

The linear incision was less than the scalloped incision, but there was slight discomfort. There was no significant difference in PI between the scalloped and linear segments.
Pocket depth and loss of attachment. Table 4 shows the mean pocket depths and loss of attachment for both segments before and after the flap procedures. The results show that for both procedures there were considerable reductions in pocket depths interdentially as well as mid-lingually and mid-buccally. Differences in the degree of pocket reduction after the scalloped incision and the linear incision were not statistically significant.

There was a mean gain in attachment level for both procedures, 12 weeks after operation, which was greater interdentally than mid-lingually and mid-buccally.

Pain experience. No pain was experienced by 20% in the first week after operation, 4% had slight pain and 3% severe pain. Of the 16 patients experiencing pain, 10 felt the pain was of equal severity on both sides of the mouth, five felt it worse on the linear side and one on the scalloped side.

Discussion

The linear incision was easier to perform than the scalloped incision and the operation was completed in less time. There was, however, a tendency for the soft tissue to "pull in" interdentally and "bunch up" on the mid-lingual and mid-buccal surfaces after the linear incision. This problem can be obviated by using less tension during suturing or by using a sling suture.

When the linear incision is used, the interdental bone is left exposed after suturing. The animal and human studies of Staffileno et al. (1962), Donnenfeld et al. (1964), Wilderman (1964) and Wilderman et al. (1970) showed that flap procedures, especially where osseous correction had been performed, led to the loss of bone. The loss was greater when the bone was denuded and not covered by soft connective-tissue when the procedure was completed. Measurements of bone loss were not made in this present study. At the end of the first post-operative week, the segments where the linear incision had been used appeared more inflamed than after the scalloped incision. In the linear incision series there was new granulation tissue in the interdental areas and in some cases exposed bone could be seen. This clinical observation was confirmed by the GI scores which mesio-buccally and disto-lingually were measuring the newly formed tissue after the linear incision and showed a statistically significant difference ($P < 0.01$) between the segments, the linear incision segments having the higher score.

At the end of the second week the linear incision segments were still healing at a slower rate, the difference in the mean Gingival Index scores being statistically significant ($P < 0.05$). Similar trends were still apparent at the end of the third and fourth week, but 12 weeks after operation it was difficult to distinguish any difference in healing and to distinguish which incision has been used in a particular segment.

The indication shown in this study by the Gingival Index, that healing was more rapid when a scalloped incision was used is in agreement with the beliefs of Friedman (1962) and Prichard (1972) who claimed that when interdental bone is covered with soft tissue healing is more rapid.

The alteration in gingival fluid flow which occurred subsequent to the flap operations displayed a pattern similar to that observed by Sandall & Wade (1969) and Greensmith & Wade (1974). The flow of gingival fluid which had increased considerably in the first week post-operatively then reduced gradually and at the end of the fourth week was below the pre-operative level.

Prichard (1972) stated that a scalloped incision results in poor gingival form, especially on the palate, which may require a gingivoplasty to correct the contour, but this study indicated that 12 weeks after the
significance of differences between the two techniques calculated by applying Student's t-test.

Results
Twenty comparisons were evaluated in 18 patients, 10 females and eight males. The range in age was 22 to 48 years. Fifteen "split mouth" operations were performed on maxillary segments and five on mandibular segments, making a total of 40 full thickness periodontal flap procedures.

Clinical observations. It was felt that the flap procedure using the linear incision was completed in a shorter time and with greater ease than the scalloped incision though no exact timings were made.

When the flaps were sutured, the alveolar bone was completely covered with soft tissue when a scalloped incision was used, but the interdental bone was left exposed when a linear incision was used. No bone was left exposed mid-lingually or mid-buccally with either procedure. During suturing of the linear flap there was a tendency for the tissues to "pull in" slightly into the interdental areas.

The response of the tissues to the surgery varied from patient to patient. At the first post-operative visit there appeared to be differences in the healing tissue. The interdental areas in the linear incision cases appeared to be covered with a grey-yellow tissue which was clearly demarcated from the flap margins. In some cases, after both linear and scalloped incisions, the flap margins showed distinct ulceration.

Differences in healing were still apparent at weeks 2 and 3, although less marked. In the linear incision series it was still possible to detect the junction of the new interdental tissue and the original flap margin. Differences in healing in the range of the teeth were less apparent.

At the end of the fourth week both types of flaps appeared to have healed, although in some cases after the linear incision the interdental tissue still did not appear to have reached full maturity.

At the end of 12 weeks it was not possible to distinguish which incision had been used on which side in the majority of cases. However, a difference could be detected in a few cases, especially on the palatal aspect. The major difference was in the maturity of the new interdental tissue formed after using the linear incision.

Table 1. Mean Gingival Indices, gingival fluid measurements and Plaque Indices for each segment before and after operation (S = scalloped, L = linear)

<table>
<thead>
<tr>
<th></th>
<th>Week 1</th>
<th>Week 2</th>
<th>Week 3</th>
<th>Week 4</th>
<th>Week 12</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>S</td>
<td>L</td>
<td>S</td>
<td>L</td>
<td>S</td>
</tr>
<tr>
<td>Gingival Index</td>
<td>4.6</td>
<td>4.8</td>
<td>2.27</td>
<td>2.48</td>
<td>1.62</td>
</tr>
<tr>
<td>Gingival fluid (mm)</td>
<td>1.51</td>
<td>1.30</td>
<td>4.90</td>
<td>5.45</td>
<td>2.62</td>
</tr>
<tr>
<td>Plaque Index</td>
<td>0.26</td>
<td>0.24</td>
<td>0.20</td>
<td>0.21</td>
<td>0.20</td>
</tr>
</tbody>
</table>

* Difference significant (P < 0.01)
** Difference significant (P < 0.05)
All other differences NS.
Table 2. Mean flow of gingival fluid (mm) from each segment before and after operation (S = scalloped, L = linear) Dargestellte Werte für das Ausfließen der Gingivalflüssigkeit (mm) an jedem Segment vor und nach der Operation (S = giriandenförmig, L = linear) Moteur moyen du fluide gingival (mm) de chaque segment avant et après l'intervention (S = giriandé, L = rectiligne)

<table>
<thead>
<tr>
<th>Pre-operative</th>
<th>Week 1</th>
<th>Week 2</th>
<th>Week 3</th>
<th>Week 4</th>
<th>Week 12</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>L</td>
<td>S</td>
<td>L</td>
<td>S</td>
<td>L</td>
</tr>
<tr>
<td>Mean</td>
<td>1.31</td>
<td>1.30</td>
<td>4.90</td>
<td>5.43</td>
<td>2.62</td>
</tr>
<tr>
<td>Diff.</td>
<td>0.01</td>
<td>0.05</td>
<td>0.38</td>
<td>0.15</td>
<td>0.83</td>
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<tr>
<td>T</td>
<td>1.02</td>
<td>0.12</td>
<td>0.18</td>
<td>0.52</td>
<td>0.88</td>
</tr>
<tr>
<td></td>
<td>NS</td>
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<td>NS</td>
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</table>

Clinical Index. The mean Gingival Indices for each segment are shown in Table 1. At the end of the first week after operation on both sides there was a marked increase in GI. There was a significant difference between the scalloped and linear segments with the linear segment having a higher GI. At 2 weeks after operation there was no improvement in GI for both segments but the linear segment still had a significantly higher score. The improvement in GI scores continued at weeks 3 and 4 and there was no statistically significant difference between the two sides. By week 12 both mean segment scores were the same.

Crevicular fluid. The mean flow of gingival fluid from each segment before and after operation is shown in Table 2. It can be seen that the flow of gingival fluid followed the same overall pattern as the GI, but the differences between the segments were not statistically significant. By the end of the fourth post-operative week, the mean flow from both segments was less than that collected prior to operation and by week 12 the flow had decreased further.

Contour Index. The mean pre-operative scores of 2.04 for the scalloped and 2.06 for the linear segments were not significantly different. Twelve weeks after operation the CI scores had been reduced to 0.92 and

<p>| Table 3. Mean Plaque Indices for both segments before and after operation (S = scalloped, L = linear) Durchschnittswerte für Plaqueindices an beiden Segmenten vor und nach der Operation (S = giriandenförmig, L = linear) Meure de des Indices de Plaque pour les deux segments avant et après l'intervention (S = giriandé, L = rectiligne) |
|--------------------------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|</p>
<table>
<thead>
<tr>
<th>Pre-operative</th>
<th>Week 1</th>
<th>Week 2</th>
<th>Week 3</th>
<th>Week 4</th>
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<tr>
<td>S</td>
<td>L</td>
<td>S</td>
<td>L</td>
<td>S</td>
<td>L</td>
</tr>
<tr>
<td>Mean</td>
<td>0.26</td>
<td>0.24</td>
<td>0.20</td>
<td>0.21</td>
<td>0.20</td>
</tr>
<tr>
<td>Diff.</td>
<td>0.02</td>
<td>0.01</td>
<td>0.03</td>
<td>0.02</td>
<td>0.22</td>
</tr>
<tr>
<td>T</td>
<td>0.89</td>
<td>1.04</td>
<td>0.48</td>
<td>0.84</td>
<td>0.45</td>
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<tr>
<td></td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
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</tbody>
</table>
flap procedure there was no significant difference between the contour produced by a scalloped or linear incision. This supported the belief of Kirkland (1936) that even if the scalloped incision provided a better aesthetic result initially it provided no long-term benefit.

When comparing the results of the scalloped and linear segments, there was a suggestion of a slightly greater reduction in mean pocket depths after the linear incision, as stated by Prichard (1972), which was more evident in the interdental areas. The differences were not, however, statistically significant.

Of the 15 patients who experienced pain, there did not appear to be any significant difference in severity between the procedures. Pain tended to be even on both sides of the mouth although five out of the 16 considered it worse on the linear side. The only patient who complained of severe pain stated that it had been of equal severity on both sides. Hence it appears that by leaving the interdental bone exposed as in the linear incision, there is no great increase in incidence of pain.

The following conclusions were reached:

1. After reverse bevel flap procedures there was initially greater inflammation in the linear incision segments than in the scalloped incision segments. Three weeks after the operation there was little difference in the degree of healing.

2. Overall there was no difference between the use of scalloped and linear incisions, which are likely to be of practical significance.

Zusammenfassung

Ein Vergleich zwischen girlandenförmiger und gerader Schnittführung bei unverkörcherer Bewehr-Technik

Anfänglich parodontaler Eingriff mit unverkörcherer Bewehr-Technik wurde bei zwanzig Pati-