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Scaling and root planing vs. conservative surgery in the treatment of chronic periodontitis

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The recent Centers for Disease Control estimate that approximately 50% of the adult population of the USA has periodontitis (24) represents a significant increase over previous reports (7). Even if this new information motivates more people to seek dental treatment, past trends in patient referrals (22, 50) suggest that much of the newly diagnosed periodontal disease will continue to be managed, at least initially, in the offices of general dentists.

The status of periodontal treatment within general dental practices has been the subject of several published reports. The American Dental Association's 2005–2006 Survey of Dental Services Rendered (5) estimated that the average general practice delivered approximately 170 nonsurgical procedures annually, including scaling and root planing, full-mouth debridement and periodontal maintenance. A more recent survey of periodontal referral patterns suggested that 57% of responding general dentists and 80% of their hygienists performed nonsurgical periodontal therapy (50). This same survey reported that 24% of the responding dentists performed periodontal surgery at least occasionally. This is similar to two other recent surveys of periodontal care in general practices. The first, by Lanning et al. (49), reported that 21% of general dentists surveyed performed pocket reduction surgery. The second was based on the responses of 650 respondents to a 2008 Dentaltown online poll, in which 39% answered yes to the question, 'Do you perform periodontal surgery in your practice?' (1).

Regardless of whether or not these reports reflect current trends, the decades-old model of diagnosis and nonsurgical therapy in a general practice, followed by specialty referral if additional treatment is needed, is not always the way that periodontal care is delivered. The American Academy of Periodontology guidelines (10) suggest that periodontal health should be achieved in the least-invasive and most cost-effective manner possible. In this regard, the general dentist has several conflicting responsibilities: first, to provide the best care for his/her patients; second, to maintain a busy practice commensurate with his level of training; and, third, to honor a patient's occasional reluctance to engage with an additional provider for care.

The American Academy of Periodontology guidelines (10) further suggest that patients with moderate or severe levels of periodontal disease, or patients with more complex cases, will best be managed by a partnership between the dentist and periodontist. If the traditional specialty referral model is becoming less suitable for the modern general dentistry practice, how effective can periodontal therapy be without specialty-level care? Setting aside those who have had advanced training in surgical techniques, most general dentists are not prepared to offer the full scope of periodontal treatment. Therefore, the surgical procedures that these dentists are able to provide are likely to be simpler procedures that can be accomplished without extensive training and/or armamentarium.

The purpose of this paper was to examine evidence regarding some of the more simple surgical procedures in the treatment of chronic periodontitis. To do this, we will compare the well-known clinical benefits

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of nonsurgical therapy (specifically scaling and root planing) with those of gingivectomy, flap debridement, modified Widman flaps, the excisional new attachment procedure and the laser-assisted new attachment procedure. The use of the word 'simple' in this context is not to imply that these techniques require no skill; they are 'simple' only in comparison with more advanced procedures. We will restrict our discussion to chronic periodontitis because we believe that treatment of aggressive disease, by any standard, should remain in the hands of a periodontist. In the end, we aim to be able to determine whether the benefits of surgical procedures in the hands of most general dentists extend beyond those of conventional nonsurgical therapy.

Response of chronic periodontitis to scaling and root planing

The role of bacterial plaque in the initiation and progression of periodontal disease is well established (77). Thus, treatment modalities aimed at biofilm control are essential for the treatment of periodontitis. Although this section will focus on subgingival instrumentation, it is essential to note that the patient's role in supragingival plaque control, through meticulous oral hygiene, is integral for the success of any periodontal therapy (14). A complete discussion of oral hygiene techniques is outside the scope of this review; however, the practitioner must bear in mind that noncompliance in oral hygiene efforts will result in unpredictable outcomes for both surgical and nonsurgical treatment.

Scaling and root planing allows for the removal of both supra- and subgingival deposits. Whilst scaling implies the removal of plaque, calculus and stains on a crown or root surface, root planing is the removal of cementum or surface dentin that is rough, impregnated with calculus or contaminated with toxins or microorganisms (4). These contaminants can take the form of a layer of bacterial plaque and associated toxic products, calculus or affected cementum.

The role of calculus as an 'extender' of the plaque front has been well documented (27). Brayer et al. (17) found that in 86% of untreated root surfaces, at least 10% of the root surface area was covered with calculus, and the apical extent of calculus can most often be found at the mid-depth of intrabony defects (73). Powell & Garnick (68) demonstrated that the width of calculus ranged from 1 to 6 mm in probing depths ranging from 2 to 7 mm with a plaque-free zone averaging 0.5 mm; based on these findings, the author recommended instrumenting beyond the extent of calculus when root planing. This is consistent with Waerhaug's observations, correlating loss of attachment and the apical extent of plaque (83).

Complete calculus removal, especially with the closed approach of scaling and root planing, is extremely difficult to perform. For example, in diseased sites deeper than 5 mm, one study showed that complete calculus removal was achieved only 11% of the time (82). Other factors shown to affect the success of calculus removal include the distance of the deposit from the cemento–enamel junction (73), the ability to detect calculus on the root surface (76), the experience of the clinician (17) and the location of calculus on a furcation vs. nonfurcation surface (26, 55).

Apart from calculus, cementum-bound endotoxin has the potential to affect gingival fibroblast attachment and proliferation (8). Although endotoxin is reported to be loosely adherent to the root surface (59), the likelihood of complete removal of all endotoxin by root planing is questionable (45). In total, the studies cited above suggest that although considered a noninvasive treatment modality, scaling and root planing is technically a very demanding procedure.

Fortunately, for both clinician and patient, a positive response to scaling and root planing is possible in spite of the difficulties encountered in performing the technique. The ability of scaling and root planing to reduce inflammation, as demonstrated by reduction in bleeding on probing and gingival index scores, has been well established (34). Although there is evidence that nonsurgical therapy, including scaling and root planing, reduces tooth loss by up to 58% over time (42), most studies reference the surrogate indicators of probing depth reduction, clinical attachment level gain and bleeding on probing as the primary clinical parameters when evaluating responses to therapy.

The literature further suggests that the response to treatment is influenced by the severity of the disease being treated. Whilst perhaps best classified according to the amount of attachment loss (12), most studies of nonsurgical therapy characterize disease severity based on initial probing depth. A comprehensive meta-analysis of nonsurgical treatment studies reported that for patients with chronic periodontitis, following scaling and root planing at sites with probing depths of 4–6 mm, clinicians should expect a mean reduction in probing depth of about 1 mm and an average gain in clinical attachment level of approximately 0.5 mm (43). At deep sites (probing depth $\geq$ 7 mm), the probing depth reduction should average approximately 2 mm and the gain in attachment level about 1 mm (43). The added effect of antibiotic therapy in chronic periodontitis has been found to be modest, but statistically significant, with an additional 0.2–0.6 mm decrease in probing depth and 0.1–0.2 mm clinical attachment level gain over scaling and root planing alone (43). The use of chemotherapeutic agents, including antibiotics, is further discussed in another article in this volume.

At sites with moderate disease, there appear to be differences in response to scaling and root planing based on tooth type. According to Pihlstrom et al. (67), sites with probing depth of 4–6 mm associated with nonmolar teeth demonstrated greater probing depth reduction following scaling and root planing than those sites associated with molar teeth. At deep sites this difference was not observed. Additionally, clinical improvements following scaling and root planing may be related to the furcation status of molar teeth. Ehnevid & Jansson (23) reported that probing depth reduction was 0.5 mm less in treated sites adjacent to molars with furcation invasions of degree 2 or degree 3 compared with sites adjacent to molars with furcation invasions of degree 1 or less.

In shallow (1–3 mm) sites, scaling and root planing leads to mean probing depth reductions of less than 0.5 mm, as well as slight amounts of attachment loss (60). The loss of probing attachment in shallow sites can, in part, be attributed to both gingival thickness as well as the amount of inflammation indicated by bleeding on probing. According to Claffey & Shanley (20), shallow sites with thin gingiva that did not demonstrate bleeding on probing were those most likely to lose attachment after scaling and root planing, which should serve as a warning to clinicians to limit root planing to sites with clinical signs of disease.

Conservative surgical interventions

Conservative surgical alternatives to nonsurgical therapy have been described in the periodontal literature for over 100 years. In this section we have selected a handful of the best known of these techniques for review; they are listed in descriptive terms followed by clinical evidence to support their use.

Gingivectomy

First introduced by Robicsek in 1883 (74, 80), the gingivectomy technique has been defined by Grant et al. (32) as the excision of the soft-tissue wall of the pocket. The major objectives of gingivectomy in the treatment of periodontal disease include complete eradication of suprabony soft-tissue pockets, in combination with gingivoplasty, to achieve an overall harmonious soft-tissue or physiologic contour (30, 84). The end goal should be the re-establishment of the gingiva in a manner that aids the patient's efforts in maintaining long-term periodontal health. Contraindications for gingivectomy include situations in which initial incisions would be made in the alveolar mucosa, when eradication of the pocket would result in complete elimination of the attached tissue or when intraosseous defects are present (29, 30, 84). As a result of these limitations, the indications for gingivectomy in the treatment of periodontal disease are somewhat restricted and this procedure is more commonly reserved for treating drug-influenced gingival enlargement or cases of esthetic crown lengthening in which osseous recontouring is unnecessary.

According to the classic technique (Fig. 1), gingivectomy is performed by measuring the probe depth of the soft-tissue pocket and transferring that measurement to the outer aspect of the gingiva by piercing the soft tissue with an instrument. The gingiva is excised with a coronally directed external bevel incision to the base of the pocket with as broad a bevel as possible, considering the apical extent and thickness of the keratinized tissue. In doing so, effort should be made to leave some amount of connective tissue coronal to the alveolar crest. Instrumentation for the gingivectomy procedure includes surgical knives, scalpel blades, rotating diamond burs, electrosurgical instruments, lasers, or a combination of the above. Once removal of the overlying soft-tissue pocket has been accomplished, the exposed tooth/root surfaces are smoothed and complete calculus removal is performed. A periodontal dressing can be applied to the de-epithelialized surface for patient comfort. The tissues will typically regain their normal clinical appearance within 14 days; however, underlying remodeling will continue to occur for up to 12 weeks (6, 78).

Flap debridement

Although the first individual to treat periodontal disease using a 'flap procedure' may be unknown, several historical practitioners, including Black (1886), Ciesznyski (1914), Widman (1916) and Neumann (1921) have described surgical approaches that allow access to the underlying roots, bone and adjacent periodontal pockets (11). Various terms, including 'flap debridement' and 'flap curettage', have been used to describe these techniques, but the common feature of each is flap access without osseous resection. In 1976, Ammons & Smith (11) outlined the

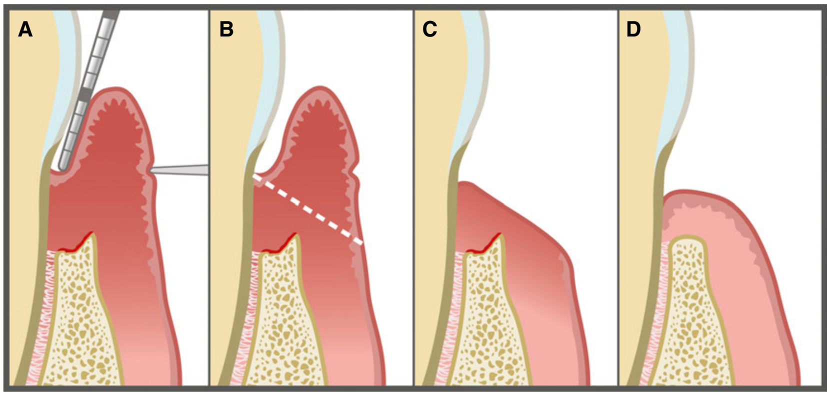

Fig. 1. **The classic gingivectomy technique consists of first marking the depth of the pocket on the external tissue surface (A). Next, a broad, externally beveled, incision is made to the base of the pocket (B). Following removal of the resected tissue (C), scaling and root planing is performed to remove tissue fragments and root accretions.**

rationale for flap surgery compared with the gingivectomy procedure: better visualization; facilitation of instrumentation for debridement; preservation of the periodontium; improved elimination or reduction of periodontal pockets; less postsurgical patient discomfort; improved esthetic outcomes; and, ultimately, improved long-term oral hygiene (11).

Several technical approaches have been described in the literature for accomplishing flap curettage or flap debridement. Typically, the procedure is initiated using sulcular or submarginal inverse bevel incisions, on both facial and lingual surfaces of teeth, that are directed at the crest of the marginal alveolar bone (Fig. 2). These incisions follow the contours of the teeth and extend as far mesially and distally as necessary to allow for passive flap reflection. Incisions are extended interproximally through the papillae to allow primary closure following surgical therapy. Vertical-releasing incisions, placed at line angles of teeth and extending into alveolar mucosa, may be incorporated if adequate reflection is not possible. Following full-thickness (mucoperiosteal) flap reflection and flap thinning, as necessary, granulation tissue is removed and root surfaces are debrided. After irrigation, flaps are replaced and sutured in an effort to achieve close adaptation to the teeth and alveolar bone. Although periodontal tissues have the ability to heal by regeneration following flap debridement (28), it is generally accepted that healing following this procedure typically results in a long junctional epithelium (79).

Modified Widman flap

The modified Widman flap, a specific type of flap debridement procedure, was introduced by Ramfjord & Nissle in 1974 (70). Although the original Widman flap was a pocket-elimination procedure, the modified technique was described for the purpose of 'intimately adapting healthy collagenous tissues to tooth surfaces' (70, 71). The modified Widman flap includes an initial internally beveled incision parallel to the long axis of the teeth to the alveolar crest, reflection of the mucoperiosteal flap 2–3 mm beyond the alveolar crest, a crevicular incision around the neck of the teeth and surgical excision of the remaining collar of tissue (Fig. 3). In addition, the palatal flap features an exaggerated scalloped design to allow close interproximal flap adaptation (70).

In 1977, Ramfjord (71) stated that the modified Widman flap procedure is indicated for deep pockets, intrabony pockets and areas where minimal recession

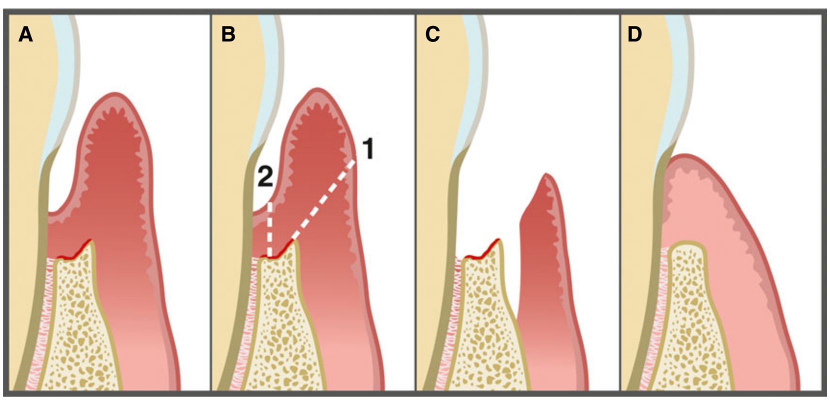

Fig. 2. **Flap debridement can be initiated with either an internally beveled (submarginal) incision or an intrasulcular incision. If the internally beveled incision (1) is used, an intrasulcular incision (2) is required to free the collar of tissue (B). The flap is then reflected (C), allowing access for root debridement before readapting the flap with sutures.**

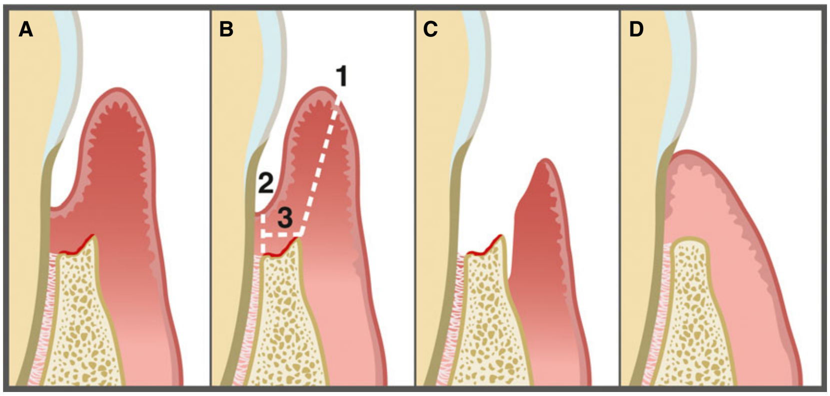

Fig. 3. The modified Widman flap utilizes three incisions to remove a collar of tissue before flap reflection. Incision 1 is an internally beveled (submarginal) incision to the alveolar crest that tapers into the sulcus interproximally. Incision 2 is a sulcular incision, and incision 3 is a connecting incision between the base of incisions 1 and 2, allowing for removal of the collar of tissue (B). Following minimal flap reflection to expose the alveolar crest (C), root debridement is completed before readapting the flaps and suturing.

is desired (71). However, a disadvantage of the procedure is the flat or concave interproximal architecture sometimes seen following the procedure, which can complicate oral hygiene. Although these soft-tissue craters have been shown to decrease in depth over time (44), they tend to be found at sites with significantly deeper preoperative probing depths and deeper bone sounding measurements immediately following flap replacement.

The originators of the modified Widman flap felt that the adaptation of tissue to instrumented root surfaces would lead to 'reattachment' ('new attachment' according to the current definition) of connective tissue fibers and formation of new cementum developing from the apical aspects of periodontal defects (70). In reality, as discussed by Ramfjord in 1977 (71), the maintenance of periodontal health by this procedure is 'by the mechanism of a long epithelial attachment and close connective tissue adaptation with or without reattachment of connective tissue and with or without regeneration of bone'.

Gingival curettage and the excisional new attachment procedure

For many years, gingival curettage was a popular conservative periodontal-treatment modality. As originally described, gingival curettage was designed to promote new connective tissue attachment to root surfaces by removing the pocket lining and junctional epithelium with a curette (19, 40). Recommended for use either during or subsequent to scaling and root planing, gingival curettage was eventually found to add nothing to the clinical improvements following root planing and is therefore no longer recommended as a clinical procedure (9).

The excisional new attachment procedure, defined by its authors as 'definitive subgingival curettage performed with a knife', was first described by Yukna et al. in 1976 (85). Conceived as a new attachment procedure for suprabony pockets, the excisional new attachment procedure was designed to eliminate the technical problems of subgingival curettage by providing better access, visualization of the root surface and more complete removal of pocket epithelium. Following the delivery of local anesthetic and marking the base of the pocket, a scalloped internally beveled partial-thickness incision is made from the crest of the free gingival margin to the base of the pocket (Fig. 4). A curette is then used to excise all soft tissue from within the pocket. Next, scaling and root planing is performed to the base of the incision. The gingiva is then repositioned whilst maintaining passive contact with the root surface and secured with interproximal or vertical mattress sutures (85, 86). Digital pressure is applied for at least 3 minutes to minimize clot formation and maximize contact of the gingiva with the root surface. When in clinical practice the placement of the initial incision proved difficult, a modified excisional new attachment procedure (Fig. 5) was introduced that described the initial incision as terminating at the alveolar crest rather than the base of the pocket (25).

Laser-assisted new attachment procedure

The latest in the line of 'conservative' periodontal treatment modalities is the laser-assisted new attachment procedure, a technique that utilizes a specific neodymium:yttrium-aluminum-garnet (Nd:YAG) laser along with occlusal adjustment, splinting (where necessary) and scaling and root planing to promote

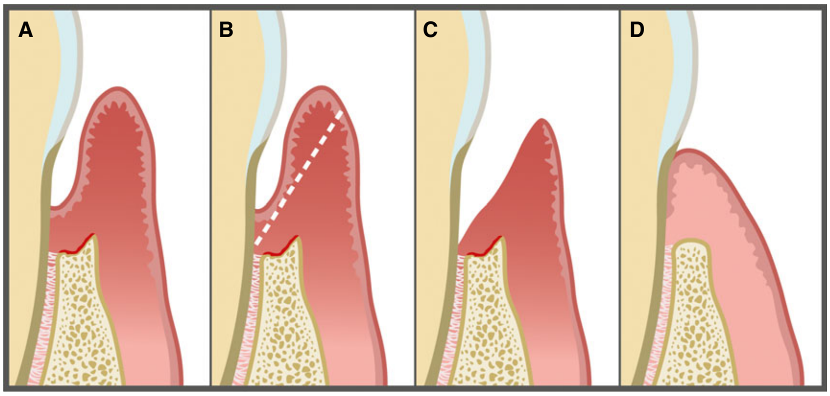

Fig. 4. The excisional new attachment procedure, as first described, employs an internally beveled (submarginal) incision to the base of the periodontal pocket (B). Once the collar of tissue is removed with curettes (C), definitive scaling and root planing is performed before readapting the gingival tissue with digital pressure and/or sutures.

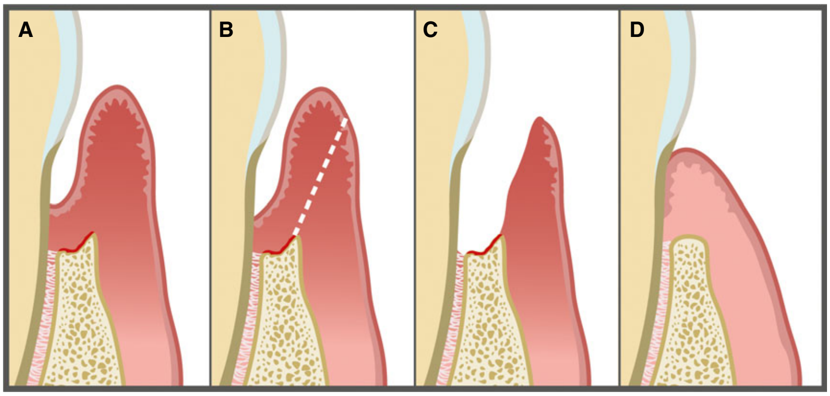

Fig. 5. A modification to the excisional new attachment procedure procedure employs a submarginal incision to the alveolar crest rather than the base of the pocket (B). Following removal of the incised tissue (C), root debridement and tissue adaptation are performed as in the original excisional new attachment procedure.

new attachment or periodontal regeneration. Both the laser and the specific technique are patented properties of Millennium Dental Technologies Inc., and received US Food and Drug Administration clearance in July 2004 (81).

The laser-assisted new attachment procedure involves a first pass with the laser inserted from the gingival margin to the base of the diseased site parallel to the root surface following which it is moved apically and laterally to remove pocket epithelium and 'decontaminate' the site (Fig. 6). According to recent reports (63, 87) this first pass has been accomplished at two different settings: 3.0 W, 150-μs pulse duration and 20 Hz in the earlier report and 4.0 W, 100-μs pulse duration and 20 Hz in the latter report. The teeth are then scaled and root planed with piezo ultrasonic instruments until the roots are smooth, before a final pass with the Nd:YAG laser from the apical extent of the defect to the gingival margin to help achieve a fibrin clot. This hemostasis step is performed at settings of 4.0 W, 650-μs pulse duration and 20 Hz (63). Finally, occlusal adjustment is performed to 'eliminate all occlusal interferences; centric, working, balancing, fremitus'. According to the leading proponents of this technique, occlusal adjustment is considered critical in maintaining an undisturbed fibrin clot, allowing healing and possible regeneration (R. A. Yukna, personal communication).

Clinical trials of conservative periodontal surgery techniques

Glickman studied the results of gingivectomy in a clinical trial comprising 250 patients with varying degrees of disease severity. Patients were followed from 3 months to 7 years, and gingival health, with sulcus depths of up to 2 mm, was maintained. Relapse was noted only in patients who experienced inadequate calculus removal or curettage, those with overhangs or food impaction and those with poor plaque control (29).

When comparing the results of gingivectomy with modified Widman flap in the short-term treatment (6 months) of 14 patients presenting with bilateral intrabony defects, Proestakis et al. found no statistically significant differences between the groups regarding probing depth reduction or clinical attachment level gain. However, significant differences were noted in that the modified Widman flap sites presented with less bleeding on probing at 6 months, whilst the gingivectomy sites had a higher percentage

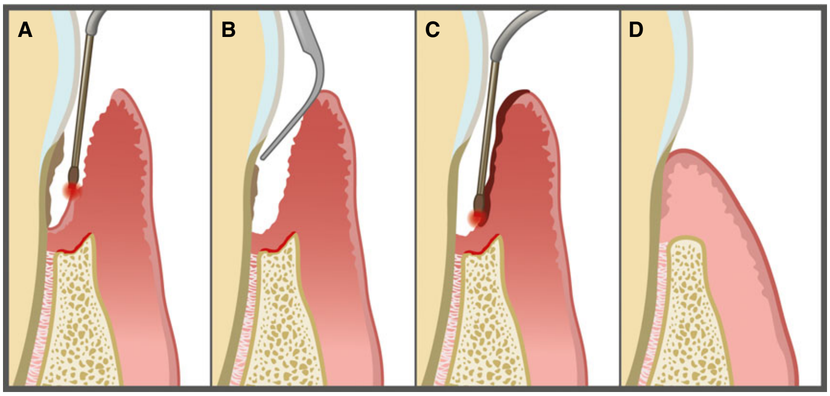

Fig. 6. The laser-assisted new attachment procedure protocol includes a first pass with the laser moved apically and laterally to both remove the epithelial pocket lining and decontaminate the site (A). Following root debridement with a piezo ultrasonic instrument (B), a second pass is made with the laser, at a different setting, from the apical extent of the pocket to the gingival margin in order to achieve a fibrin clot (C).

of probing depths ranging from 1 to 3 mm (72% vs. 58%) and more recession (1.92 mm vs. 1.57 mm) (69).

Several authors have compared the modified Widman flap with other modalities of therapy (16, 39, 46, 48). Knowles et al., in a split-mouth design, evaluated root planing with subgingival curettage, modified Widman flap surgery and pocket elimination surgery (either by gingivectomy or by apically positioned flap and osseous surgery). Periodontal maintenance was performed every 3 months. Modified Widman flap and pocket elimination surgery resulted in greater pocket reduction than curettage, especially at deeper sites. All procedures resulted in clinical attachment level gain; however, the modified Widman flap resulted in the greatest attachment gains after 8 years (48).

Kaldahl et al. (46) evaluated 82 patients with moderate to severe chronic periodontitis in a longitudinal comparison of treatment modalities. Each patient had one quadrant assigned randomly to one of four procedures: coronal scaling; scaling and root planing; modified Widman flap surgery; and osseous resective surgery. Patients were evaluated at baseline, 4 weeks after initial therapy, 10 weeks following definitive therapy and annually before periodontal maintenance appointments that were conducted at 3-month intervals. Fifty-one patients completed the evaluation at 7 years. Similarly to the results of Knowles et al. (48), there were no differences between sites treated with modified Widman flap surgery and scaling and root planing by the end of year 3 for the 5- to 6-mm sites and by the end of year 5 for sites ≥ 7 mm. Modified Widman flap surgery and scaling and root planing generated greater clinical attachment level gain than osseous surgery in 5- to 6-mm sites, but this difference diminished during maintenance (46).

In further evaluation of their data, Kaldahl et al. (47) regrouped sites based on post-treatment probing depths recorded 10 weeks following surgery. The incidence of sites losing attachment of ≥ 3 mm/year from baseline in the initial 5–6 mm category, according to treatment modality, was as follows: scaling and root planing = 0.81%; modified Widman flap surgery = 0.76%; and flap osseous = 0.45%. In sites initially ≥ 7 mm the incidence of sites losing ≥ 3 mm of attachment per year, according to treatment modality, was as follows: scaling and root planing = 1.21%; modified Widman flap surgery = 1.34%; and flap osseous = 0.48%. Ten per cent of patients accounted for most sites losing attachment. From this data it can be seen that sites treated by modified Widman flap surgery and scaling and root planing were, for the most part, equally at risk for future attachment loss (47).

Yukna & Williams (86) evaluated the excisional new attachment procedure after 5 years, and compared their data with 1- and 3-year results for 33 teeth in nine patients. During this time period, patients were recalled on what the authors described as a ‘roughly quarterly basis’ for evaluation, prophylaxis and plaque control instructions. Following treatment, the mean initial probing depth of 4.7 mm was reduced to 1.9 mm at year 1, 2.3 mm at year 3 and 2.9 mm at year 5. The original 2.5 mm of new attachment at year 1 was reduced to 1.9 mm at year 3 and 1.5 mm at year 5 (86). Between the 1- and 5-year evaluations there were increases in probing depth and attachment loss, in spite of low plaque scores throughout the evaluation period. Interestingly, only 2% of the probing depths and 9% of the attachment level measurements improved between the 1- and the 5-year evaluations. Yukna & Williams (86) stated that the 1.5 mm mean value of retained new attachment at the 5-year evaluation compared favorably with the 0.5-mm gain for the modified Widman flap for similar sites, as reported by Knowles et al. (48, 86).

A retrospective study by Tilt evaluated 107 consecutive patients treated using the laser-assisted new attachment procedure who averaged 6.2 (range: 3.0–9.25) years in maintenance therapy (81). Thirty-four patients were classified as ADA Case Type III, whilst the remaining 73 were ADA Case Type IV. Any tooth deemed to have a hopeless prognosis (41 teeth) was removed pretreatment, leaving 2,696 teeth in the study. A total of 81 (3.0%) teeth were lost during maintenance for all reasons, of which 46 (1.7%) were lost because of periodontal disease. Tooth loss was calculated at 0.43 teeth/patient over this time period. Two hundred and eighty teeth (10.4%) in 42 patients required site-specific retreatment with the laser-assisted new attachment procedure during the evaluation period 'based on recurrence of infection and progression of pocket depth.' Patients with more severe disease initially (ADA Case Type IV) had 3.5 times more sites with significant probing depth increases during maintenance that required laser-assisted new attachment procedure retreatment (81).

A recent, single-center, prospective study evaluated short-term changes in probing depth, clinical attachment level and recession in eight patients with chronic periodontitis following treatment with the laser-assisted new attachment procedure (62). A total of 930 sites with a mean probing depth of 4.62 ± 2.29 mm, a mean clinical attachment level of 5.58 ± 2.76 mm and recession of 0.86 ± 1.31 mm were evaluated. Treatment with the full-mouth laser-assisted new attachment procedure was completed in a single visit, with prophylaxis and hygiene review following postoperative care at 2.5, 4, 5.5, 7 and 8.5 months. At 9 months, examiners noted a reduction of mean probing depth to 3.14 ± 1.48 mm, mean clinical attachment level gain to 4.66 ± 2.10 mm and recession increase to 1.52 ± 1.62 mm. A subset of 444 sites with initial probing depth ≥ 5 mm had probing depths decreased from 6.50 ± 2.07 to 3.92 ± 1.54 mm and a clinical attachment level gain from 7.42 ± 2.70 to 5.78 ± 2.06 mm. Additionally, a smaller subset of sites with initial probing depth of > 7 mm experienced pocket reduction of 4.39 ± 2.33 mm and clinical attachment level gain of $2.96 + 1.91$ mm (62). Clinical studies comparing the laser-assisted new attachment procedure with other treatment modalities are ongoing and will be needed to evaluate the utility of the laser-assisted new attachment procedure.

To date, there have been two human histologic studies on the laser-assisted new attachment procedure. In the first, Yukna et al. (87) evaluated healing in teeth extracted 3 months after treatment. In comparison with control teeth that received the same therapy with the exception of the Nd:YAG laser, there was greater probing depth reduction (4.7 mm vs. 3.7 mm) and attachment level gain (4.2 mm vs. 2.4 mm), as well as less gingival recession (0.2 mm vs. 0.8 mm), with the laser-assisted new attachment procedure. Histologically, all six laser-assisted new attachment procedure-treated teeth demonstrated new cementum and a new connective tissue attachment, with new bone formation in four of the six specimens. Five of the six control teeth healed by a long junctional epithelium, with the remaining control tooth demonstrating new cementum and a new connective tissue attachment (87). A recent study by Nevins et al. (63) reported on 10 laser-assisted new attachment procedure-treated teeth extracted in block section following 9 months of healing. Five teeth demonstrated 'a degree of periodontal regeneration' with the presence of new cementum, alveolar bone and a periodontal ligament. One tooth demonstrated new attachment, and the remaining four healed by a long junctional epithelium attachment (63).

Discussion

Both scaling and root planing and conservative periodontal surgery are effective treatments for many cases of chronic periodontitis (35, 66). However, despite recent technological advancements, enhanced instrumentation and new techniques, the success of both scaling and root planing and periodontal surgery continues to depend on plaque control, the quality of root debridement and a strict maintenance regimen (13, 51, 65). The technique used to gain access to the roots, be it nonsurgical or surgical, may be less important than the thoroughness of root debridement for long-term success, and most studies suggest that failure to clean the roots thoroughly will result in treatment failure (48, 72, 75).

As previously discussed, properly performed scaling and root planing is an effective but challenging procedure for dental providers, requiring an exacting, meticulous approach (3, 21). To begin with, scaling and root planing is uncomfortable for most patients; therefore, local anesthesia is usually required for thorough root debridement (58). Time is also an issue, for in many of the classic studies that proved the efficacy of root planing, treatment times were allotted that averaged about 10 min/tooth (35). These studies were also performed by thoroughly trained providers using sharp curettes and properly functioning ultrasonic instruments. Therefore, the thoroughness of scaling and root planing in clinical studies is very likely to exceed that achieved in a private dental office unless a special focus is given to the procedure.

The meta-analysis by Heitz-Mayfield et al. (37), of six randomized controlled trials, may be used as a summary of findings on the effectiveness of scaling and root planing vs. conservative surgical access. According to their report, at 12 months following treatment, open flap debridement resulted in slightly greater (0.6 mm) probing depth reduction and clinical attachment gain (0.2 mm) in deep pockets (> 6 mm) in nonfurcation areas. Both therapies seem effective in terms of attachment gain and reduction of gingival inflammation in shallow (1–3 mm) and moderate (4–6 mm) pockets (37). In general, studies have shown that open debridement is more effective than scaling and root planing for removal of plaque and calculus in pockets ≥ 6 mm and that operator experience plays a role, with more experienced clinicians being more effective (17, 18). In furcation areas, surgical access has been shown to be superior for debridement, with scaling and root planing alone often being unable to halt the progression of periodontitis (26, 53, 64). When scaling and root planing is compared with conservative surgery regarding the ultimate goal of tooth retention, the evidence shows that both treatments can be effective for most patients with an adequate maintenance regimen (31, 33, 41, 42, 56, 57).

One potential dilemma for the general dentist seeking to treat periodontitis with conservative surgical approaches is discovering, during the midst of the procedure, that a more complex treatment approach is required. For example, sites with prominent bone ledges and shallow craters may attain better probing depth reduction with osseous surgery (15, 46, 54). Sites with intrabony defects or furcation invasions usually respond better to bone grafting or guided tissue regeneration than to flap debridement (61). Certain biologic materials, such as enamel matrix derivative and platelet-derived growth factor, can greatly enhance the clinical response in certain situations, and these situations are unfortunately not always known before flap reflection.

Ideally, the least invasive, most cost-effective treatment should be used to restore periodontal health, and this treatment should always be based on the needs of the individual patient (2, 66). Scaling and root planing alone often suffices as definitive therapy, arresting the disease process and restoring health, comfort and function. The recent review of periodontal therapy by Heitz-Mayfield & Lang (38) confirms this, using the concept of ‘critical probing depth’ to illustrate the effectiveness of nonsurgical therapy. The concept of ‘critical probing depth’ suggests that for various periodontal therapies, there is a specific probing depth above which a given therapy will result in attachment gain, and below which that same therapy will result in attachment loss. For example, the critical probing depths for scaling and root planing and modified Widman flap surgery have been identified as 2.9 and 4.2 mm, respectively (52). In a previously mentioned clinical study, Nevins et al. determined a critical probing depth of 4.88 mm for the laser-assisted new attachment procedure (62). Although there have been questions about the statistical validity of critical probing depth (36), and acknowledging that critical probing depth values are quite dependent on the level of oral hygiene (52), these authors used the principles of critical probing depth to state a preference for nonsurgical therapy at sites with probing depths between 2.9 and 5.4 mm (38).

When scaling and root planing does not attain treatment goals, periodontal surgery should be considered as a potential next step (10). For example, the review of Heitz-Mayfield & Lang (38), mentioned above, used critical probing depth to recommend the possible added benefits of flap surgery at sites with mean probing depths ≥ 5.4 mm. That said, when considering conservative surgical approaches in patients with periodontitis, the clinician must decide: (i) if the benefit of surgical access is significantly beyond that of scaling and root planing; and (ii) if he/she is prepared for a potentially more extensive surgical procedure than initially contemplated, possibly requiring materials and skills that he/she may not possess.

Conclusion

For mild-to-moderate chronic periodontitis, treatment in the general dentist’s office should focus on establishing excellent patient plaque control and providing meticulous nonsurgical therapy to include scaling and root planing. The evidence demonstrating efficacy of this procedure as a bedrock treatment for patients with chronic periodontitis is extensive and irrefutable. Conservative surgical interventions added to scaling and root planing do not always offer significant advantages in treating mild/moderate disease. For severe periodontitis, conservative surgical interventions can offer benefits beyond scaling and root planing, as long as the clinician is prepared to move from conservative access to more complex procedures when necessary. In addition, the importance of patient compliance with a regular periodontal maintenance program cannot be overlooked as a key to success.

References

1. Dentaltown Magazine monthly online poll; "Do you perform periodontal surgery in your practice?" Farran Media L.L.C., Phoenix. https://www.dentaltown.com/dentaltown/Article.aspx?i=124&aid=1678 (accessed March 26, 2008).
2. Consensus report. Surgical pocket therapy. *Ann Periodontol* 1996: **1**: 618–620.
3. Consensus report. Non-surgical pocket therapy: mechanical, pharmacotherapeutics, and dental occlusion. *Ann Periodontol* 1996: **1**: 581–588.
4. *Glossary of Periodontal Terms*, 4th edn. Chicago: American Academy of Periodontology, 2001.
5. *2005–06 Survey of Dental Services Rendered*. Chicago: American Dental Association, 2007.
6. Afshar-Mohajer K, Stahl SS. The remodeling of human gingival tissues following gingivectomy. *J Periodontol* 1977: **48**: 136–139.
7. Albandar JM, Brunelle JA, Kingman A. Destructive periodontal disease in adults 30 years of age and older in the United States, 1988–1994. *J Periodontol* 1999: **70**: 13–29.
8. Aleo JJ, De Renzis FA, Farber PA. In vitro attachment of human gingival fibroblasts to root surfaces. *J Periodontol* 1975: **46**: 639–645.
9. American Academy of Periodontology. The American Academy of Periodontology statement regarding gingival curettage. *J Periodontol* 2002: **73**: 1229–1230.
10. American Academy of Periodontology. Comprehensive periodontal therapy: a statement by the American Academy of Periodontology *. *J Periodontol* 2011: **82**: 943–949.
11. Ammons WF Jr, Smith DH. Flap curettage: rationale, technique, and expectations. *Dent Clin North Am* 1976: **20**: 215–226.
12. Armitage GC. Development of a classification system for periodontal diseases and conditions. *Ann Periodontol* 1999: **4**: 1–6.
13. Axelsson P, Lindhe J. The significance of maintenance care in the treatment of periodontal disease. *J Clin Periodontol* 1981: **8**: 281–294.
14. Baker KA. The role of dental professionals and the patient in plaque control. *Periodontol 2000* 1995: **8**: 108–113.
15. Becker W, Becker BE, Ochsenbein C, Kerry G, Caffesse R, Morrison EC, Prichard J. A longitudinal study comparing scaling, osseous surgery and modified Widman procedures. Results after one year. *J Periodontol* 1988: **59**: 351–365.
16. Becker W, Becker BE, Caffesse R, Kerry G, Ochsenbein C, Morrison E, Prichard J. A longitudinal study comparing scaling, osseous surgery, and modified Widman procedures: results after 5 years. *J Periodontol* 2001: **72**: 1675–1684.
17. Brayer WK, Mellonig JT, Dunlap RM, Marinak KW, Carson RE. Scaling and root planing effectiveness: the effect of root surface access and operator experience. *J Periodontol* 1989: **60**: 67–72.
18. Caffesse RG, Sweeney PL, Smith BA. Scaling and root planing with and without periodontal flap surgery. *J Clin Periodontol* 1986: **13**: 205–210.
19. Carranza FA. A technic for reattachment. *J Periodontol* 1954: **25**: 272–278.
20. Claffey N, Shanley D. Relationship of gingival thickness and bleeding to loss of probing attachment in shallow sites following nonsurgical periodontal therapy. *J Clin Periodontol* 1986: **13**: 654–657.
21. Cobb CM. Non-surgical pocket therapy: mechanical. *Ann Periodontol* 1996: **1**: 443–490.
22. Cobb CM, Carrara A, El-Annan E, Youngblood LA, Becker BE, Becker W, Oxford GE, Williams KB. Periodontal referral patterns, 1980 versus 2000: a preliminary study. *J Periodontol* 2003: **74**: 1470–1474.
23. Ehnevid H, Jansson LE. Effects of furcation involvements on periodontal status and healing in adjacent proximal sites. *J Periodontol* 2001: **72**: 871–876.
24. Eke PI, Dye BA, Wei L, Thornton-Evans GO, Genco RJ, CDC Periodontal Disease Surveillance workgroup: James Beck GDRP. Prevalence of periodontitis in adults in the United States: 2009 and 2010. *J Dent Res* 2012: **91**: 914–920.
25. Fedi PF, Rosenfeld WJ. Excisional new attachment procedure. *J Mo Dent Assoc* 1977: **57**: 22–24.
26. Fleischer HC, Mellonig JT, Brayer WK, Gray JL, Barnett JD. Scaling and root planing efficacy in multirooted teeth. *J Periodontol* 1989: **60**: 402–409.
27. Friskopp J. Ultrastructure of nondecalcified supragingival and subgingival calculus. *J Periodontol* 1983: **54**: 542–550.
28. Froum SJ, Coran M, Thaller B, Kushner L, Scopp IW, Stahl SS. Periodontal healing following open debridement flap procedures. I. Clinical assessment of soft tissue and osseous repair. *J Periodontol* 1982: **53**: 8–14.
29. Glickman I. The results obtained with an unembellished gingivectomy technique in a clinical study in humans. *J Periodontol* 1956: **27**: 247–255.
30. Goldman HM. Gingivectomy. *Oral Surg Oral Med Oral Pathol* 1951: **4**: 1136–1157.
31. Goldman MJ, Ross IF, Goteiner D. Effect of periodontal therapy on patients maintained for 15 years or longer. A retrospective study. *J Periodontol* 1986: **57**: 347–353.
32. Grant DA, Stern IB, Everett FG. *Orban's Periodontics*, 3rd edn. St Louis: C.V. Mosby, 1968: p. 385
33. Graziani F, Gennai S, Cei S, Cairo F, Baggiani A, Miccoli M, Gabriele M, Tonetti M. Clinical performance of access flap surgery in the treatment of the intrabony defect. A systematic review and meta-analysis of randomized clinical trials. *J Clin Periodontol* 2012: **39**: 145–156.
34. Greenstein G. Periodontal response to mechanical non-surgical therapy: a review. *J Periodontol* 1992: **63**: 118–130.
35. Greenstein G. Nonsurgical periodontal therapy in 2000: a literature review. *J Am Dent Assoc* 2000: **131**: 1580–1592.
36. Gunsolley JC, Yeung GM, Butler JH, Waldrop TC. Is loss of attachment due to root planning and scaling in sites with minimal probing depths a statistical or real occurrence? *J Periodontol* 2001: **72**: 349–353.
37. Heitz-Mayfield LJ, Trombelli L, Heitz F, Needleman I, Moles D. A systematic review of the effect of surgical debridement vs non-surgical debridement for the treatment of chronic periodontitis. *J Clin Periodontol* 2002: **29** (Suppl. 3): 92–102. discussion 160-102.
38. Heitz-Mayfield LJ, Lang NP. Surgical and nonsurgical periodontal therapy. Learned and unlearned concepts. *Periodontol 2000* 2013: **62**: 218–231.
39. Hill RW, Ramfjord SP, Morrison EC, Appleberry EA, Caffesse RG, Kerry GJ, Nissle RR. Four types of periodontal treat-

ment compared over two years. *J Periodontol* 1981: **52**: 655–662.
40. Hirschfeld L. Subgingival curettage in periodontal treatment. *J Am Dent Assoc* 1952: **44**: 301–314.
41. Hirschfeld L, Wasserman B. A long-term survey of tooth loss in 600 treated periodontal patients. *J Periodontol* 1978: **49**: 225–237.
42. Hujoel PP, Leroux BG, Selipsky H, White BA. Non-surgical periodontal therapy and tooth loss. A cohort study. *J Periodontol* 2000: **71**: 736–742.
43. Hung HC, Douglass CW. Meta-analysis of the effect of scaling and root planing, surgical treatment and antibiotic therapies on periodontal probing depth and attachment loss. *J Clin Periodontol* 2002: **29**: 975–986.
44. Jenkins WM, Wragg PF, Gilmour WH. Formation of interdental soft tissue defects after surgical treatment of periodontitis. *J Periodontol* 1990: **61**: 564–570.
45. Jones WA, O'Leary TJ. The effectiveness of in vivo root planing in removing bacterial endotoxin from the roots of periodontally involved teeth. *J Periodontol* 1978: **49**: 337–342.
46. Kaldahl WB, Kalkwarf KL, Patil KD, Molvar MP, Dyer JK. Long-term evaluation of periodontal therapy: I. Response to 4 therapeutic modalities. *J Periodontol* 1996: **67**: 93–102.
47. Kaldahl WB, Kalkwarf KL, Patil KD, Molvar MP, Dyer JK. Long-term evaluation of periodontal therapy: II. Incidence of sites breaking down. *J Periodontol* 1996: **67**: 103–108.
48. Knowles JW, Burgett FG, Nissle RR, Shick RA, Morrison EC, Ramfjord SP. Results of periodontal treatment related to pocket depth and attachment level. Eight years. *J Periodontol* 1979: **50**: 225–233.
49. Lanning SK, Best AM, Hunt RJ. Periodontal services rendered by general practitioners. *J Periodontol* 2007: **78**: 823–832.
50. Lee JH, Bennett DE, Richards PS, Inglehart MR. Periodontal referral patterns of general dentists: lessons for dental education. *J Dent Educ* 2009: **73**: 199–210.
51. Lindhe J, Nyman S. The effect of plaque control and surgical pocket elimination on the establishment and maintenance of periodontal health. A longitudinal study of periodontal therapy in cases of advanced disease. *J Clin Periodontol* 1975: **2**: 67–79.
52. Lindhe J, Socransky SS, Nyman S, Haffajee A, Westfelt E. "Critical probing depths" in periodontal therapy. *J Clin Periodontol* 1982: **9**: 323–336.
53. Loos B, Nylund K, Claffey N, Egelberg J. Clinical effects of root debridement in molar and non-molar teeth. A 2-year follow-up. *J Clin Periodontol* 1989: **16**: 498–504.
54. Machtei EE, Ben-Yahouda A. The effect of post-surgical flap placement on probing depth and attachment level: a 2 year longitudinal study. *J Periodontol* 1994: **65**: 855–858.
55. Matia JI, Bissada NF, Maybury JE, Ricchetti P. Efficiency of scaling of the molar furcation area with and without surgical access. *Int J Periodontics Restorative Dent* 1986: **6**: 24–35.
56. McFall WT Jr. Tooth loss in 100 treated patients with periodontal disease. A long-term study. *J Periodontol* 1982: **53**: 539–549.
57. McLeod DE, Lainson PA, Spivey JD. The effectiveness of periodontal treatment as measured by tooth loss. *J Am Dent Assoc* 1997: **128**: 316–324.
58. McLeod DE. A practical approach to the diagnosis and treatment of periodontal disease. *J Am Dent Assoc* 2000: **131**: 483–491.
59. Moore J, Wilson M, Kieser JB. The distribution of bacterial lipopolysaccharide (endotoxin) in relation to periodontally involved root surfaces. *J Clin Periodontol* 1986: **13**: 748–751.
60. Morrison EC, Ramfjord SP, Hill RW. Short-term effects of initial, nonsurgical periodontal treatment (hygienic phase). *J Clin Periodontol* 1980: **7**: 199–211.
61. Murphy KG, Gunsolley JC. Guided tissue regeneration for the treatment of periodontal intrabony and furcation defects. A systematic review. *Ann Periodontol* 2003: **8**: 266–302.
62. Nevins M, Kim SW, Camelo M, Martin IS, Kim D. A prospective 9-month human clinical evaluation of Laser-Assisted New Attachment Procedure (LANAP) therapy. *Int J Periodontics Restorative Dent* 2014: **34**: 21–27.
63. Nevins ML, Camelo M, Schupbach P, Kim SW, Kim DM, Nevins M. Human clinical and histologic evaluation of laser-assisted new attachment procedure. *Int J Periodontics Restorative Dent* 2012: **32**: 497–507.
64. Nordland P, Garrett S, Kiger R, Vanooteghem R, Hutchens LH, Egelberg J. The effect of plaque control and root debridement in molar teeth. *J Clin Periodontol* 1987: **14**: 231–236.
65. Nyman S, Lindhe J, Rosling B. Periodontal surgery in plaque-infected dentitions. *J Clin Periodontol* 1977: **4**: 240–249.
66. Palcanis KG. Surgical pocket therapy. *Ann Periodontol* 1996: **1**: 589–617.
67. Pihlstrom BL, Oliphant TH, McHugh RB. Molar and nonmolar teeth compared over 6 1/2 years following two methods of periodontal therapy. *J Periodontol* 1984: **55**: 499–504.
68. Powell B, Garnick JJ. The use of extracted teeth to evaluate clinical measurements of periodontal disease. *J Periodontol* 1978: **49**: 621–624.
69. Proestakis G, Soderholm G, Bratthall G, Kullendorff B, Grondahl K, Rohlin M, Attstrom R. Gingivectomy versus flap surgery: the effect of the treatment of infrabony defects. A clinical and radiographic study. *J Clin Periodontol* 1992: **19**: 497–508.
70. Ramfjord SP, Nissle RR. The modified widman flap. *J Periodontol* 1974: **45**: 601–607.
71. Ramfjord SP. Present status of the modified Widman flap procedure. *J Periodontol* 1977: **48**: 558–565.
72. Ramfjord SP, Caffesse RG, Morrison EC, Hill RW, Kerry GJ, Appleberry EA, Nissle RR, Stults DL. 4 Modalities of periodontal treatment compared over 5 years. *J Clin Periodontol* 1987: **14**: 445–452.
73. Richardson AC, Chadroff B, Bowers GM. The apical location of calculus within the intrabony defect. *J Periodontol* 1990: **61**: 118–122.
74. Robicsek S. Über Wesen und Entstehen der Alveolarpyorrhoe und deren Behandlung. XXXIII Jahresber d Ver Oesterr Zahnärzte 1883–1884.
75. Rosling B, Nyman S, Lindhe J, Jern B. The healing potential of the periodontal tissues following different techniques of periodontal surgery in plaque-free dentitions. A 2-year clinical study. *J Clin Periodontol* 1976: **3**: 233–250.
76. Sherman PR, Hutchens LH Jr, Jewson LG. The effectiveness of subgingival scaling and root planing. II. Clinical responses related to residual calculus. *J Periodontol* 1990: **61**: 9–15.
77. Socransky SS, Haffajee AD, Smith GL, Dzink JL. Difficulties encountered in the search for the etiologic agents of destructive periodontal diseases. *J Clin Periodontol* 1987: **14**: 588–593.

78. Stahl SS, Witkin GJ, Cantor M, Brown R. Gingival healing. II. Clinical and histologic repair sequences following gingivectomy. *J Periodontol* 1968: **39**: 109–118.
79. Stahl SS, Froum SJ, Kushner L. Periodontal healing following open debridement flap procedures. II. Histologic observations. *J Periodontol* 1982: **53**: 15–21.
80. Stern IB, Everett FG, Robicsek K. S. Robicsek – a pioneer in the surgical treatment of periodontal disease. *J Periodontol* 1965: **36**: 265–268.
81. Tilt LV. Effectiveness of LANAP over time as measured by tooth loss. *Gen Dent* 2012: **60**: 143–146.
82. Waerhaug J. Healing of the dento-epithelial junction following subgingival plaque control. II: As observed on extracted teeth. *J Periodontol* 1978: **49**: 119–134.
83. Waerhaug J. The angular bone defect and its relationship to trauma from occlusion and downgrowth of subgingival plaque. *J Clin Periodontol* 1979: **6**: 61–82.
84. Waite IM. The present status of the gingivectomy procedure. *J Clin Periodontol* 1975: **2**: 241–249.
85. Yukna RA, Bowers GM, Lawrence JJ, Fedi PF Jr. A clinical study of healing in humans following the excisional new attachment procedure. *J Periodontol* 1976: **47**: 696–700.
86. Yukna RA, Williams JE Jr. Five year evaluation of the excisional new attachment procedure. *J Periodontol* 1980: **51**: 382–385.
87. Yukna RA, Carr RL, Evans GH. Histologic evaluation of an Nd:YAG laser-assisted new attachment procedure in humans. *Int J Periodontics Restorative Dent* 2007: **27**: 577–587.