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Surgical lengthening of the clinical crown: a periodontal concept for reconstructive dentistry

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This review presents the various techniques, the indications and contraindications for surgical lengthening of the clinical crown.
Based on the concept of biologic width of the dento-gingival complex, the aim of surgical modifications in this region is to create a distance of approximately 3 mm between the foreseeable marginal area of a reconstruction and the crest of the alveolar bone.
Studies on wound healing suggest that stability of the soft tissues following such surgical procedures is obtained after a healing period of 6 months. In order to obtain optimal aesthetic treatment outcomes of restorations, the duration of the healing period should be respected.

■ Introduction

When reconstructing a tooth, successful aesthetic and functional treatment outcomes are based on the observation of endodontic and periodontal health of the respective abutments. In addition, aspects of remaining tooth substance leading to adequate retention for the future reconstructions are of importance. In cases where caries lesions or previous reconstructions extend into the subgingival compartment, surgical lengthening of the clinical crown may be necessary. Also, tooth fractures in the coronal third, and endodontic complications, such as perforations during root canal preparations or external root resorption in this region, may indicate surgical lengthening of the clinical crown. In essence, such procedures represent preprosthetic surgical interventions during which the periodontal attachment of a future abutment tooth is deliberately reduced in order to improve the conditions for optimal tooth reconstruction, thereby assuring long-term periodontal and functional stability.

■ Rationale

Prosthetic procedures require the recognition of a well-defined preparation margin. If such margins are placed in the gingival sulcular region, an unfavourable situation for impression taking results. Moreover, optimal control of the marginal fit of the future reconstruction may be difficult in situations when margins extend deeply into the subgingival area. Consequently, surgical lengthening of the clinical crown may optimise the conditions for precise impression taking.

The prepared abutment should represent a retentive core to guarantee both retention and stability of a prosthetic reconstruction. To gain vertical dimension for this biomechanical aspect, surgical crown lengthening may be indicated.

Extensively worn teeth may require a correction in the extent and outline of the gingival contours. A similar situation may be encountered with a so-called 'gummy smile' that requires gingival plastic surgery to achieve optimal aesthetic results.

Based on a classic study on autopsy material, the dimensions of the dento-gingival unit have been recognised as remarkably constant[1]. A total distance from the alveolar crest to the buccal gingival margin of approximately 3 mm, consisting of a sulcus depth of 0.69 mm, an epithelial attachment distance of 0.97 mm and a connective tissue fibre investment into the root surface of 1.07 mm has been described[1]. However, it should be remembered that these dimensions represent mean values with great individual and topographical variations within the dentition. Similar results with relatively constant dimensions of the periodontium in humans were observed by Vacek et al[2]. Based on 171 teeth in 10 human cadavers, a sulcus depth of 1.34 mm (± 0.84 mm), epithelial attachment of 1.14 mm (± 0.49 mm), and connective tissue attachment of 0.77 mm (± 0.32 mm) were reported[2]. The results suggested that the connective tissue attachment exhibited much smaller variations than the dimensions of the epithelial attachment[2]. Also, the biotype of a patient may define the dimensions of the dento-gingival unit and hence the biologic width may vary between a thick and short biotype and a thin and long biotype. Finally, it is evident that the interproximal region yields different biologic widths when compared with the buccal or lingual areas[3].

Invasion of the biologic width by placing restoration margins into the subgingival compartment may lead to inflammation, attachment loss, alveolar bone loss and/or recessions[4]. Even in the presence of adequate plaque control, subgingival restorations produce gingivitis. However, in the absence of plaque control, attachment loss is inevitable[5]. Although uncontrolled bone loss as a result of an invasion of the biologic width has been demonstrated in various animal studies, only a few human studies confirm the concept that the invasion of the biologic width will result in inflammation, clinical attachment loss and recession[6-17].

■ Indications

For practical reasons, the corono-apical dimensions of the dento-gingival unit in conjunction with the placement of restorations may be estimated at approximately 3 mm[8]. Modifications of that dimension may be required for particular clinical situations[18-19].

Surgery to increase the length of the clinical crown is indicated in a variety of clinical conditions:

- deep subgingival finishing lines of a reconstruction preventing precise impression taking or the control of it;
- deep subgingival carious lesions to be treated;
- root fractures in the cervical third of the root;
- root resorptions in the cervical third of the root;
- inadequate mechanical retention of a presumptive reconstruction due to reduced clinical crown height;
- presence of restoration margins deeply placed into the subgingival area leading to inflammation and loss of attachment, which cannot be controlled with other procedures;
- in combination with root amputations, hemisections or tunnelling procedures to provide access for oral hygiene practices;
- aesthetic improvement of cases with a high smile line and a so-called 'gummy smile'.

■ Contraindications

Lengthening of the clinical crown represents only part of a complete and comprehensive treatment plan to reconstruct a dentition. Prior to the actual surgical

procedure, the patient should have undergone comprehensive treatment planning, and the systematically approached sequential phases, such as the initial and definitive phases of periodontal therapy, should be completed successfully. In relation to a planned fixed reconstruction, the surgical lengthening of the clinical crown may be performed in combination with or in isolation from periodontal surgical therapy.

Contraindications may arise in patients at high risk from surgical interventions. Furthermore, in patients with unsuccessful completion of the initial phase of periodontal therapy, surgical lengthening of the clinical crown may need to be postponed until plaque control is satisfactory. In cases where the surgical lengthening of the clinical crown will jeopardise the integrity of a furcation region, thus resulting in a deterioration of the periodontal condition, the procedure is contraindicated. Finally, if the tooth shows periodontal bone loss to the apical third of the root, crown lengthening is irrational, and therefore severely periodontally compromised teeth should not be selected for surgical lengthening of the clinical crown.

■ Clinical procedures

The following techniques have been advocated to increase the length of the clinical crown:

- gingivectomy,
- apically repositioned flap,
- orthodontic tooth eruption with or without crown lengthening.

■ Gingivectomy[20]

Owing to the fact that the performance of gingivectomies may jeopardise the dimensions of the gingiva, this procedure should only be performed in cases with existing pseudo-pockets, gingival overgrowth or 'gummy smile'. An adequate zone of attached gingiva should be maintained following surgical intervention.

■ Apically repositioned flap[21]

Although originally designed for pocket elimination, apically repositioned flaps have often been advocated in conjunction with the surgical lengthening of the clinical crown[22-25]. Scalloped paramarginal incisions, performed buccally and lingually, in conjunction with two releasing incisions into the alveolar mucosa were recommended[21]. Following the raising of a full thickness flap beyond the mucogingival line, a marginal tissue collar was removed to give access to the root surfaces and the exposed alveolar crest. Alveolar bone was subsequently recontoured to mimic the physiological architecture of the alveolar process. Careful root planing, directed to remove periodontal ligament fibres inserting supracrestally into the cementum, was performed. Finally, the flaps were repositioned in an apical direction and sutured[21]. It should be emphasised that this procedure maintains the dimensions of the attached gingiva. However, it may result in open (secondary intention) wound healing in the interproximal area.

■ Orthodontic tooth eruption with or without crown lengthening

Lengthening the clinical crown may also be achieved by orthodontic forced eruption, by applying low eruption forces. The attachment apparatus, including the gingival periodontal fibres and alveolar bone, follows the tooth. Hence, lengthening of the clinical crown can only be achieved by elimination of pseudo-pockets. If the tooth is erupted orthodontically without affecting the length of the clinical crown, surgical crown lengthening may subsequently be required if this had been the primary goal of therapy prior to reconstruction.

Another principle that has been advocated is to avoid coronal positioning of the attachment apparatus by combining forced orthodontic eruption with regular fibrotomy. An intracrevicular incision was performed to cut the supracrestal periodontal fibres[35-38]. Large orthodontic forces were subsequently used to move the tooth or root coronally 'out of the bony housing' without maintaining the attachment level[26-38]. However, such forced eruption has only been reported in case reports and a case series. No well-controlled studies are available to evaluate the predictability of the outcome.

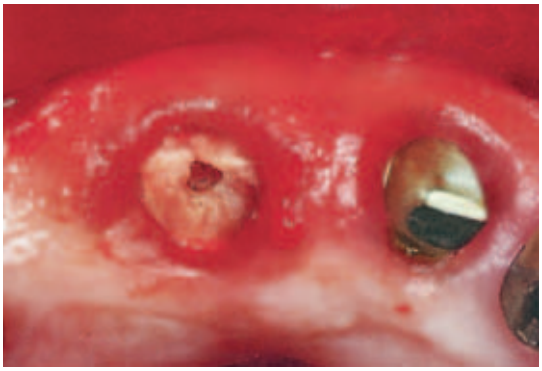


Fig 1 Roots of teeth 11 and 21 are planned to support a fixed partial denture with an extension (x 11 21: where x is the extension in position 12, 11 a PFM crown and 21 a PFM crown). The margin of the crown of tooth 21 will be placed deeply subgingivally, and hence surgical lengthening of the clinical crown is indicated.

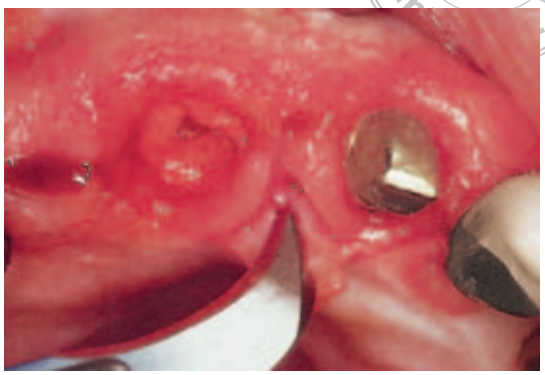
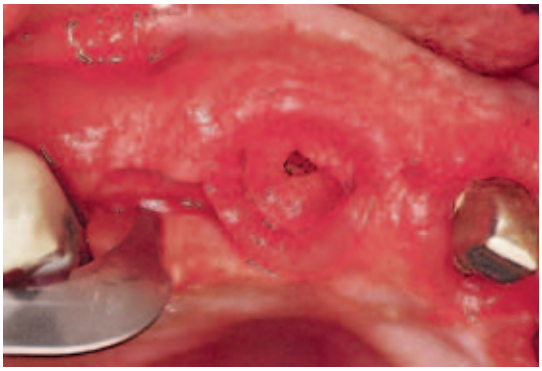


Fig 2 A scalloped incision in the long axis of the tooth is performed. This will enable an apical repositioning of the flap after the lengthening of the clinical crown.



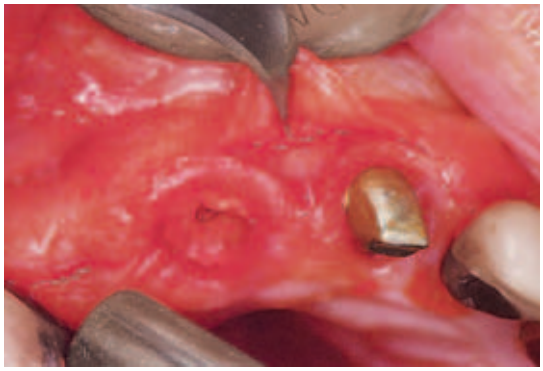


Fig 3 and 4 Undermining incisions are performed and the flap is elevated.

■ The surgical crown lengthening procedure

In contrast to apical repositioning of a flap[21] for the surgical lengthening of the clinical crown where it is likely to result in open wound margins, leading to secondary wound healing by granulation tissue, the contemporary procedure is based on recent developments in periodontal flap surgery. Close flap adaptation leading to primary flap closure and uneventful healing is sought. Hence, papilla preservation is considered in the design of the flaps[39-40]. The step-by-step procedure is described in detail below.

After terminal or block anaesthesia with adrenalin to reduce bleeding during surgery, the first incision is made to bone contact along the long axis of the tooth. This incision is generally placed intrasulcularly, but depending on the amount of tissue to be reduced may be placed paramarginally by, at most, 1 mm. Scalloping will help preserve the interdental papillae (Figs 1 and 2).

A full mucoperiosteal flap is then subsequently elevated, disclosing the surgical field, providing visibility and access to the root surfaces and the alveolar crest (Figs 3 and 4). Using sharp curettes, granulation tissue and tissue tags are removed (Figs 5 and 6).

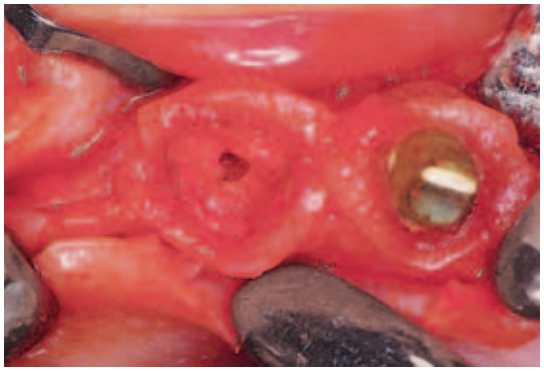


Fig 5 A circular excision of the tissue collar is performed.

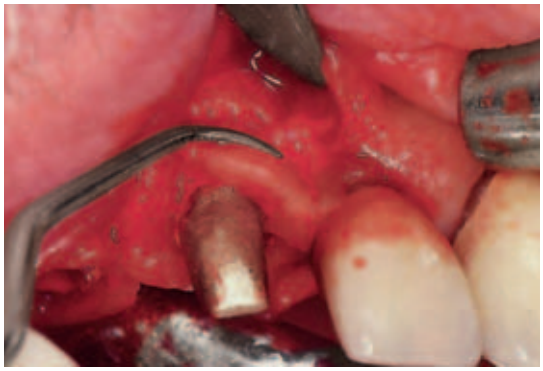


Fig 6 Using curettes the abundant soft tissue is eliminated.

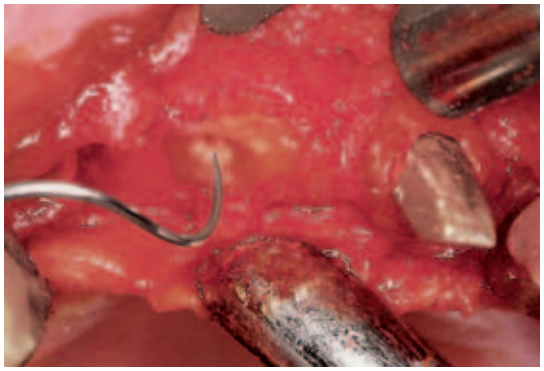


Fig 7 A carious lesion in dentine was found to extend to the level of crestal alveolar bone.

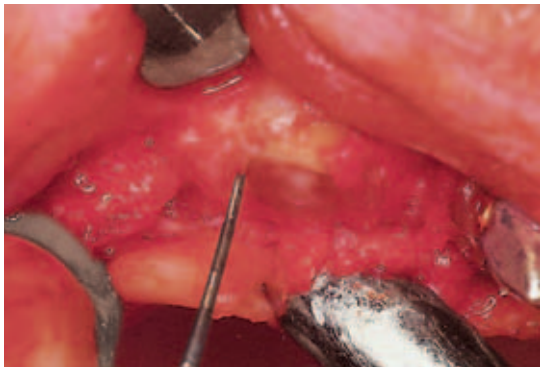
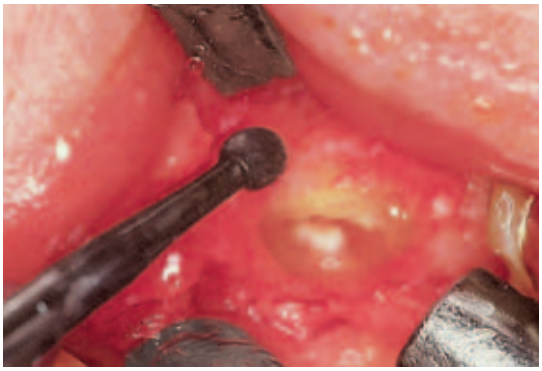


Fig 8 The distance from the future restoration margins of teeth 11 and 21 to the alveolar crest should be at least 3 mm.

The amount of osteoplasty and/or osteoectomy required has to be estimated, keeping in mind the dimensions of the biologic width of future reconstructions. In this case, a 3 mm distance between the finishing line of the planned reconstructions and the alveolar crest is observed (Figs 7 and 8).

Using round burs under abundant cooling with sterile saline, and finishing the osteoectomy with hand curettes, the bone is re-sculptured to meet the 3 mm distance (Figs 9 to 12). The scalloped bony contour parallel to the cemento-enamel junction should be maintained. After complete exposure of the necessary supracrestal region on the root surface, remnants of the periodontal ligament fibres attached to the cementum are thoroughly removed with extensive root planing. Using this procedure, reattachment of remaining connective tissue fibres with the fibres of the flap can be prevented. The final shaping of the osteoplasty and osteoectomy should always be performed with hand curettes in order to avoid root damage with round burs. Fine diamond tips (PerioSet®; Intensiv AG, Lugano, Switzerland) may also be applied for finishing the root surface (Figs 13 to 15).

Abundant irrigation with sterile saline should precede flap adaptation to remove debris from the surgical site. To press the flaps against the underlying



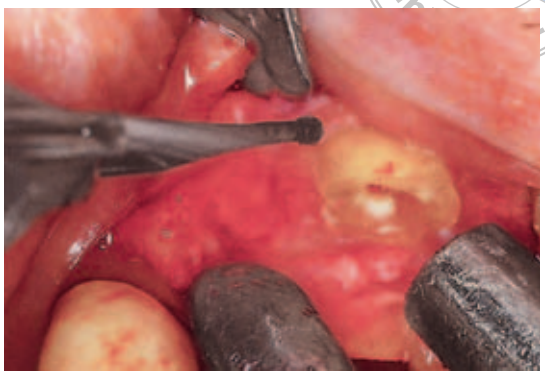
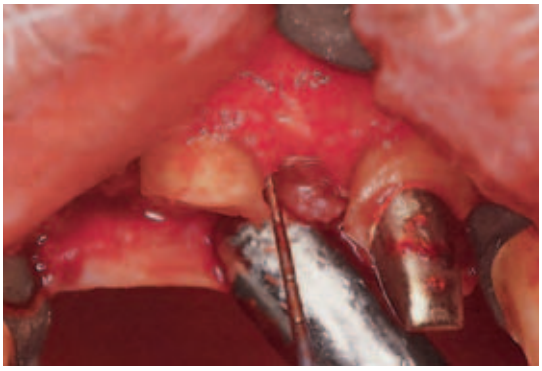


Fig 9 and 10 Under constant cooling with sterile saline, alveolar bone is removed using round burs (osteoectomy). Caution is taken not to damage the root surface.



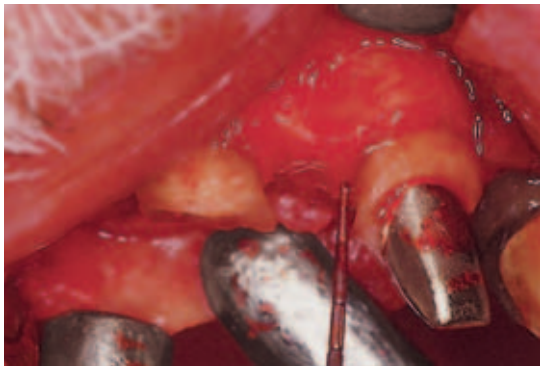
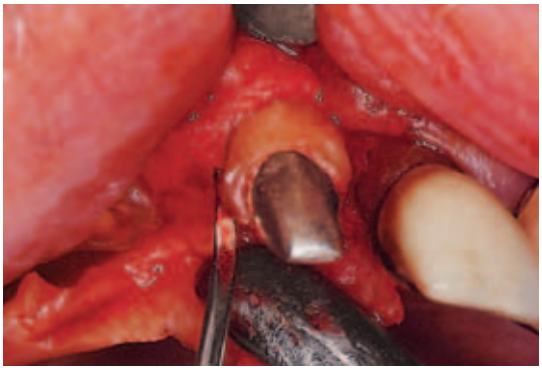
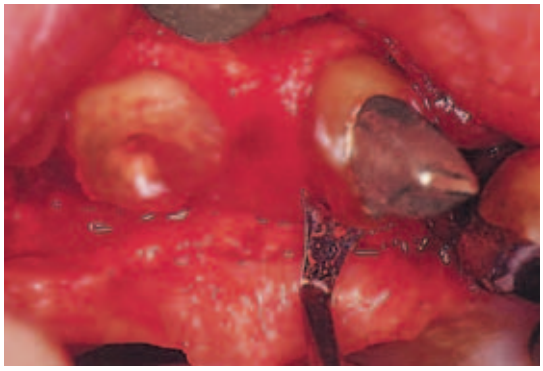


Fig 11 and 12 The distances of 3 mm are verified.





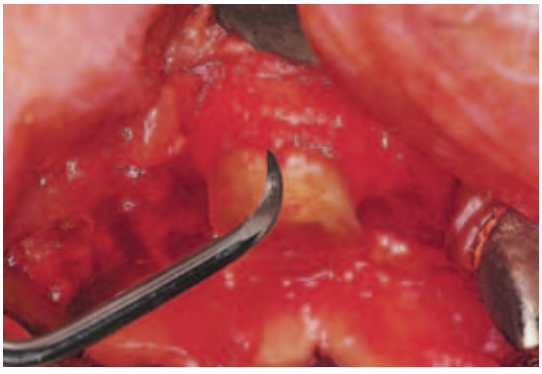


Fig 13 to 15 Following removal of the soft tissue and the alveolar bone for lengthening of the clinical crown, the roots are thoroughly planed, and remaining periodontal fibres eliminated to prevent reattachment of the connective tissue to the root surface.

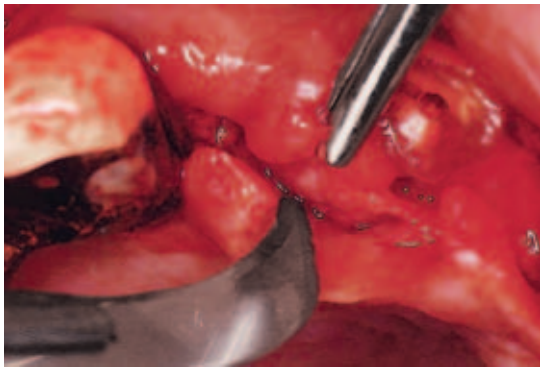


Fig 16 The palatal flap is trimmed for improved adaptation.

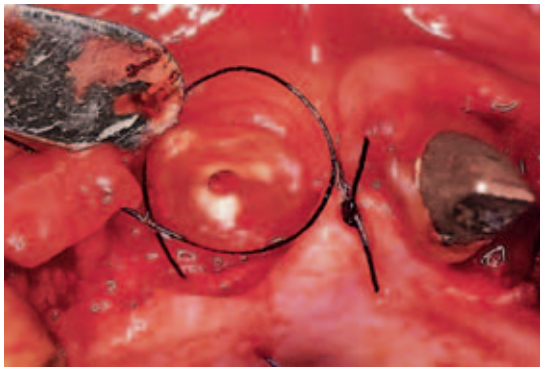
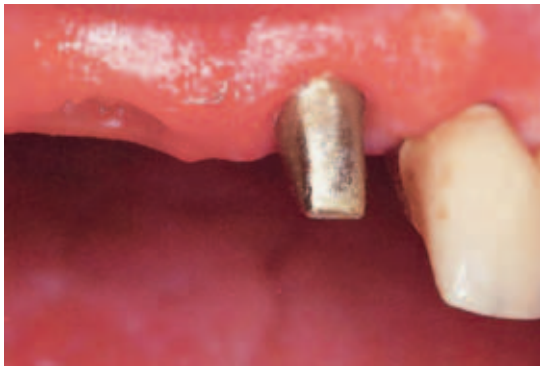


Fig 17 Placement of (sling) sutures to adapt the flaps.



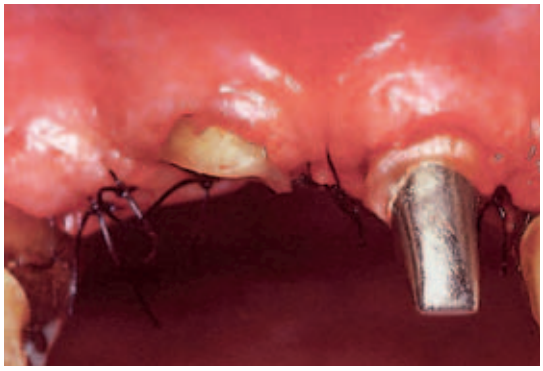
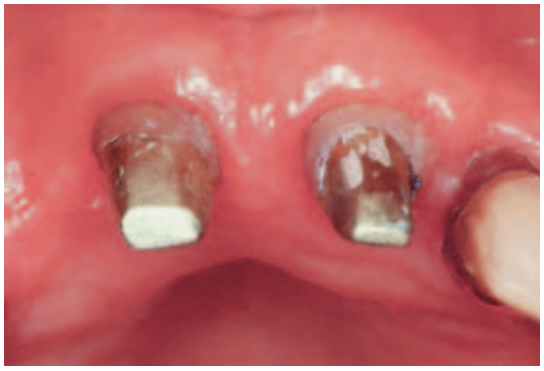


Fig 18 and 19 The surgical sites before and after the performance of surgical crown lengthening. The roots can now be restored properly.



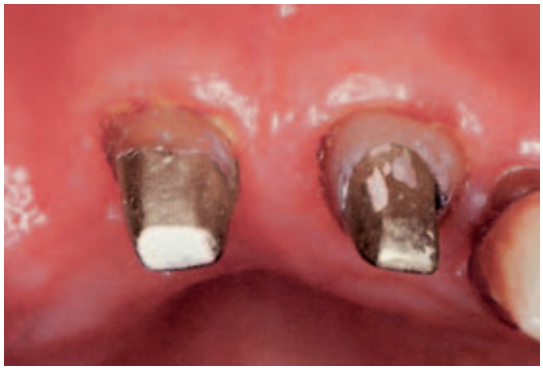


Fig 20 and 21 After 6 months, the tissues have healed and retraction cords may be placed for impression taking. The patient has rinsed twice daily with a 0.1% chlorhexidine gluconate solution for 4 weeks.

and re-sculptured bone and hence adjust the flap margins for optimal primary closure, external mattress (or sling) sutures are advocated (Figs 16 to 19). Post-operative care includes the administration of non-steroidal anti-inflammatory medication and the application of antiseptic rinses with 0.1–0.2% chlorhexidine digluconate solution, preferably for 4 weeks (Figs 20 and 21). The use of a very soft surgical toothbrush for mechanical cleaning as well as for applying 0.2% chlorhexidine gel may be recommended from the third day post-operatively[41]. Sutures are usually removed after 1 week.

■ Scientific evidence and discussion

A case control study assessed the changes in the periodontal tissue levels as an immediate result of surgical lengthening of the clinical crown, over a 6-month healing period[42]. Compared with sites not exposed to any surgical procedure, changes in the level of the free gingival margin during the healing period were minimal. This suggests that the placement of the flap margin at the time of surgery defined the position of the free gingival margin in most cases. However, between 6 weeks and 6 months of healing, a recession of 2 mm or more was observed in 12% of the patients, indicating a need for a substantial observation period prior to the reconstructive process[42].

Results of a more recent study[43] indicate that healing times required to stabilise the height of gingival tissues may vary between patients. Remodelling of soft tissue may be more pronounced in thick and wide tissue biotypes compared with thin and slender biotypes. The latter may also experience more recessions. The healing of crown lengthening procedures and the re-establishment of the biologic width have been studied[44]. In 18 patients, 19% of the sites treated required ≥ 3 mm of osteoectomy. After 3 months, the gingival margin was displaced apically by 3.05 mm, 2.68 mm at the adjacent tooth sites, and 2.48 mm at the non-adjacent tooth sites. At 6 months, the biologic width was completely re-established and remained stable[44]. It is evident that 6 months are required following surgical crown lengthening to achieve homoeostasis. In areas of aesthetic priority, 6 months may be required between crown lengthening and the final reconstruction despite the fact that in a great proportion of the cases stability of the tissue could be achieved after 3 months[44].

Since impression taking may be preceded by application of retraction cords that may, at least temporarily, impinge on the periodontal health of an abutment tooth and result in gingival recession, less traumatic and only minimally invasive procedures should be chosen to avoid gingival recession[45]. This is especially true for a thin tissue biotype.

Changes in alveolar bone density 1 and 6 months after surgical lengthening of the clinical crown, have been studied using subtraction radiography[46]. There was a significant increase in density between 1 and 6 months post-surgically in most cases (85%), but no statistically significant difference was observed in density changes after 6 months when comparing sites that had undergone crown lengthening procedures with sites that were not surgically treated (controls). This indicates that healing was completed 6 months after surgical lengthening of the clinical crown.

In conclusion, in areas of aesthetic priority it is important to observe a 6-month healing period following surgical lengthening of the clinical crown and prior to impression taking. A distance of 3 mm between the level of the alveolar crest and the level of the finishing line of the reconstruction appears to result in stable periodontal tissue after a period of 6 months.

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