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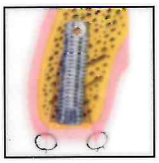
Socket Seal Surgery Combined With Immediate Implant Placement: A Novel Approach for Single-Tooth Replacement



*Cobi J. Landsberg, DMD**

Guided bone regeneration procedures around immediately placed implants may result in well-osseointegrated fixtures, but because of complexed flap manipulation, the functional, phonetic, and esthetic result may be unsatisfactory, especially when performed in the maxillary anterior region of the mouth. For better results a modified ridge preservation technique, called "socket seal surgery," which combines bone and soft tissue grafting and is performed prior to implant placement has been suggested. A novel approach is presented in which socket seal surgery is performed simultaneously with implant placement to achieve optimal replacement of an extracted maxillary anterior tooth. (Int J Periodont Rest Dent 1997;17:141–149.)

*Private Practice, Tel-Aviv, Israel.

Reprint requests: Dr Cobi J. Landsberg, 53 Gordon St, Tel-Aviv, Israel 64394. E-mail: cobilan@netvision.net.il

Alveolar ridge resorption following tooth removal is a physiologically undesirable but an unavoidable phenomenon.[1] In most cases the residual ridge defect becomes a problematic site that is difficult to restore, both functionally and esthetically either by a "conventional" tooth-supported restoration or by an implant-anchored restoration. Recently the development of guided tissue regeneration (GTR) procedures that may regenerate bone in deficient sites of the jaws expanded the possibilities for implant placement.[2–14] These osteopromotive procedures may be performed either prior to[5,8,9,14] or simultaneously with implant placement.[2–4,6,7,10–13] In either case, a membrane barrier is used to allow only bone-forming cells to repopulate the deficient bony site. The membrane that must cover the whole bony defect should, in turn, preferably be completely covered by soft tissue during the entire healing process, which takes 6 to 9

months for sufficient maturation of the regenerated bone to be achieved.[5–12]

However, immediately after tooth extraction a soft tissue gap is created on top of the ridge (as a result of the open socket), and submerging the membrane under protective soft tissue may necessitate complex flap manipulation.[3,9–11] This usually involves some undesirable side effects, such as marginal gingival recession of the adjacent teeth and loss of keratinized gingiva and interdental papillary height.[11] Such soft tissue loss may significantly compromise esthetics and phonetics, especially in the maxillary anterior region of the mouth. To prevent these undesirable results, a modified regenerative approach, called "socket seal surgery" (SSS), has been suggested in which flap elevation is not performed while bone and soft tissue grafts are used, thus enabling optimal preservation of the ridge topography immediately after tooth extraction.[15] However, it takes 6 to 9 months for regenerated bone to become mature and suitable for implant placement. To eliminate the waiting period between tooth extraction and implant placement, a modified technique is presented, whereby SSS is performed simultaneously with implant placement immediately postextraction.

Clinical procedure

Examination and assessment of the implant site

As no flap elevation is performed prior to implant placement, the topography and quality of the ridge should be thoroughly evaluated clinically, radiographically, and occasionally by computerized tomographic (CT) scan. If, for example, a large buccopalatal bony depression exists apical to the tooth to be removed, flap elevation and a conventional membrane barrier should preferably be used for ridge augmentation prior to or simultaneously with implant placement.

Surgical steps

Socket preparation. After gentle tooth extraction without flap elevation, the fresh socket is thoroughly debrided of granulation tissue and residual periodontal ligament fibers. The socket bony walls are further decorticated to increase the participation of endosteal bone-forming cells in the wound. The gingival walls at the socket orifice are gently de-epithelialized by a water-cooled high-speed coarse diamond bur, thereby exposing the vascularized lamina propria responsible for nourishing and revascularizing the soft tissue graft to be placed later at the socket orifice.

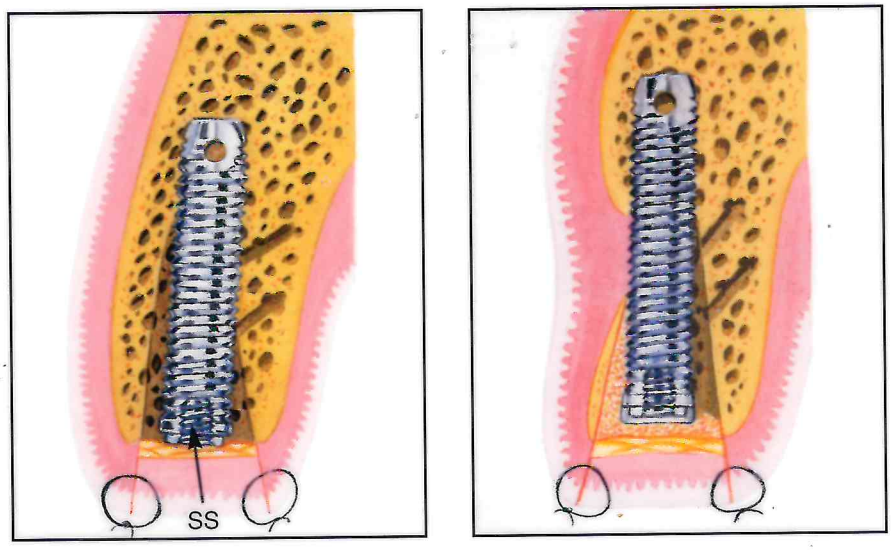
Implant placement. For functional and esthetic reasons, the implant should be placed axially and centrally in the socket orifice. To achieve optimal implant position, the use of a guiding surgical stent may be helpful. A medium diameter (usually 4 mm) implant is preferred, and the implant head should be located 1 to 2 mm apical to the labial crest, or occasionally level with the labial crest. In this situation a modified coverscrew that has no head ("space screw") is used to minimize implant protrusion from the socket and to allow adequate space for placement of the soft tissue graft. Usually the ridge converges toward the nasal spine; therefore drilling should be directed slightly palatal to the socket apex to avoid penetration into the vestibular mucosa (Fig 1a). However, there are situations in which, for anatomic or prosthetic reasons, the drills must be directed in such a way that slight fenestration of the buccal plate may occur. It is then extremely important not to penetrate but only lift up the periosteum with the drills and subsequently with the implant itself (Fig 1b).

Bone grafting. Decalcified freeze-dried particulated bone allograft (DFDBA) or powdered autogenous bone harvested from the osteotomy is grafted between the implant body and the labial plate if the latter is

very thin and likely to resorb. A thin layer of bone graft may be placed also on top of the implant to help prevent soft tissue participation in the regenerated bone around the implant (Fig 1b).

Soft tissue grafting. Depending on the shape of the socket orifice, a circular or elliptical 3- to 4-mm-thick soft tissue graft that contains part of the submucosa is obtained from the palate. The graft should be slightly wider than the socket orifice and is placed on top of the cover screw or the bone graft particles to completely seal the socket, slightly "pushing" against the gingival walls. The graft is secured in place by four to six simple sutures located circumferentially, each passing through the graft and the gingival wall (Figs 1a and 1b).

Post operative instructions. The patient should be administered 100 mg of doxycycline tablets once daily for 7 days and 500 mg Diflunisal tablets three times daily as needed. Patients should also be instructed to use 0.2% chlorhexidine rinses for 1 minute twice daily and to avoid any kind of physical disturbance of the wound area. After 7 to 10 days, the sutures are removed and the patient is given further instructions. At this time, the patient may be allowed to wear a temporary restoration for the missing tooth.



Figs 1a and 1b *A schematic presentation of the SSS performed simultaneously with implant placement.* (left) *Decortication* (D) *of socket bony walls is usually made at the palatal aspect of the socket. Implant is directed slightly palatal to the socket apex to avoid buccal plate penetration. "Space screw" (SS) is used when the implant head is almost level with the labial crestal bone. The soft tissue graft* (STG) *includes the fatty submucosa* (S). *Bone grafting around the implant is usually not carried out.* (right) *Fenestration* (F) *of the buccal plate. The support of the thin cortical labial plate is achieved by decalcified freeze-dried bone allograft (DFDBA) or autogenous bone graft.*

Clinical cases

Case 1

A 58-year-old woman presented with a request to replace her collapsing maxillary restoration with an implant-supported fixed maxillary bridge. This case report focused on the problems and surgical treatment of the incisor tooth area. Clinical observation revealed residual roots that had been cut even to the gingival margins. Periapical radiographs revealed extensive apical resorption of all roots, periapical radiolucency (asymptomatic) associated with the left central root, and large bone radiolucencies (asymptomatic) apical to the right central root. A CT scan revealed a deep ridge concavity mainly associated with the right lateral and left central incisor roots; only the site of the right central incisor root was adequate for implant insertion. The roots were removed and extraction sites were treated as follows: The site of the right central root was treated by SSS simultaneously with implant placement; the site of the left central root was treated by SSS only; and, at a later visit, the site of the right lateral root was treated by SSS only. The major treatment steps performed are illustrated in Figs 2a to 2h.

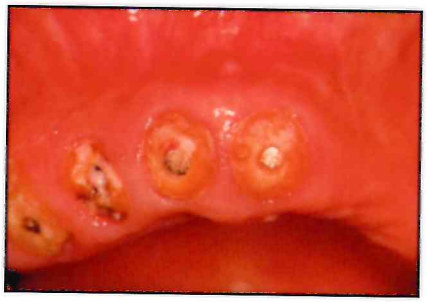


Fig 2a (above) *Clinical view of maxillary incisor tooth area.*

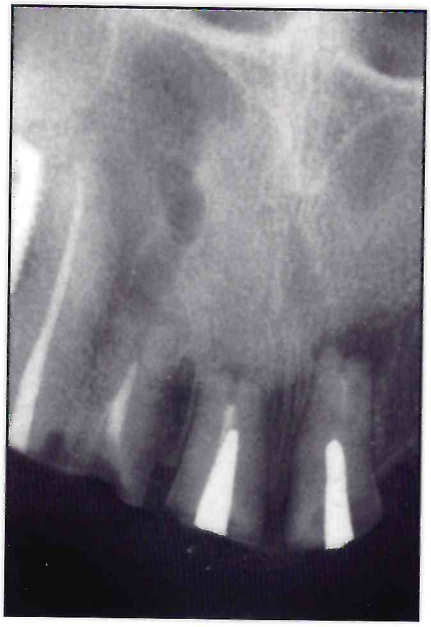


Fig 2b (right) *Radiographic periapical view of the root of the left central incisor and the radiolucency apical to the apex of the root of the right lateral incisor.*

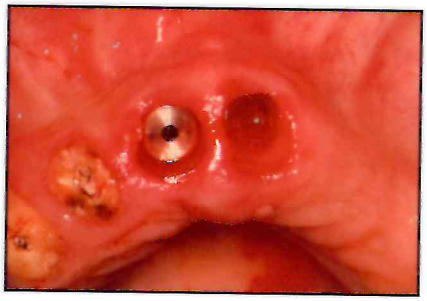
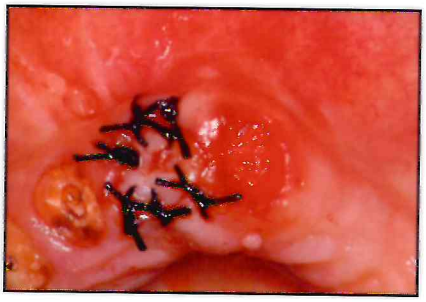


Fig 2c *Brånemark fixture placed immediately postextraction of the right central root. Note the intact soft tissue orifice of the sockets.*



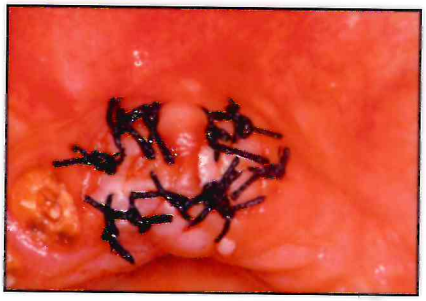
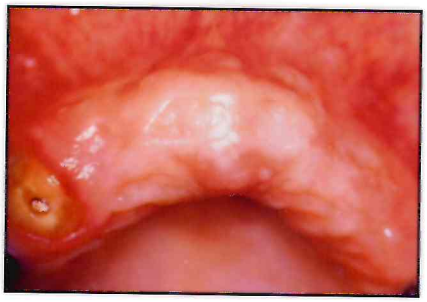
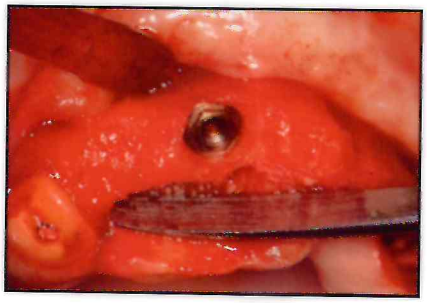
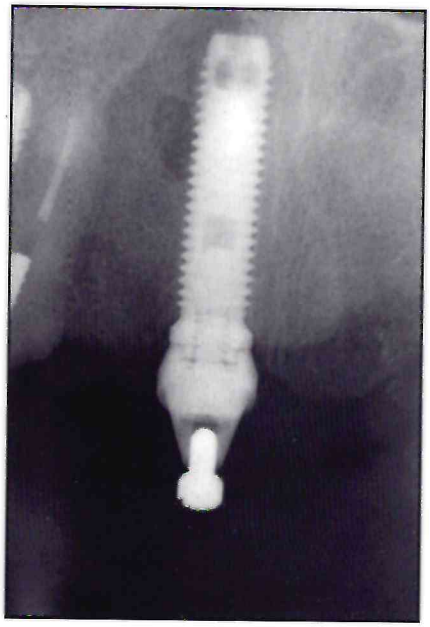


Fig 2d (top) *Gingival graft placed on top of the cover screw and sutured. Freeze-dried bone particles are grafted only in the neighboring socket.*

Fig 2e (bottom) *Another gingival autograft is placed to seal the socket of the left central root.*







Figs 2f, 2g, and 2h *Five months post-SSS in the extraction sites of the central roots and 4 months post-SSS in the extraction site of the right lateral root.* (top left) *The width of the residual ridge has been maintained.* (bottom left) *The implant is circumferentially surrounded by bone and the ridge topography in the incisor teeth area has been maintained.* (right) *Radiographic periapical view. The fixture appears well osseointegrated and passes close to the bone radiolucency that was initially present.*

Case 2

A 67-year-old man presented with pain associated with the maxillary right central incisor. Clinical examination revealed a mobile porcelain crown with minimal retention to the root. The neighboring teeth were completely intact except for the right lateral incisor, which had a Class III discolored composite restoration. The crown attached to its post was easily removed, revealing a stable but moderately fractured root. No pathology was detected radiographically, and a CT scan of the area revealed a slight ridge concavity apical to the root apex.

After a detailed explanation of the treatment options to the patient, the patient chose to replace the tooth with a single implant-supported restoration. Socket seal surgery, combined with immediate implant placement as previously described, was the surgical treatment selected. The major steps performed are illustrated in Figs 3a to 3j.

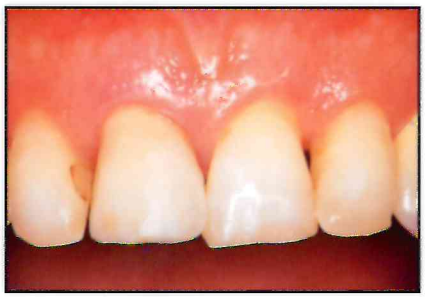


Fig 3a (above) *Preoperative maxillary anterior teeth of Case 2. Note the asymmetry of the incisor teeth anatomy. The crown of the right central incisor was mobile.*

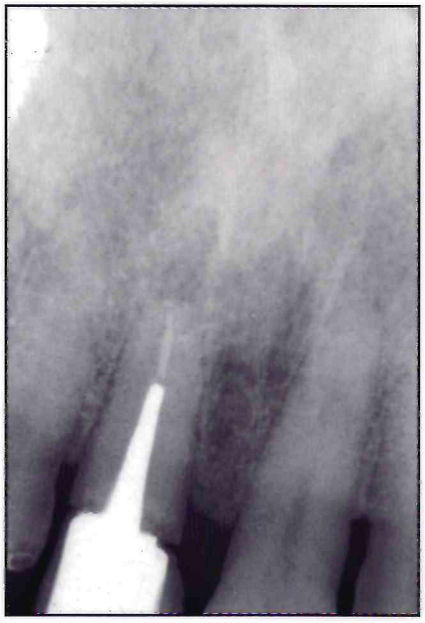


Fig 3b (right) *Radiographic view of the area of the central incisors. Note the inadequate crown-root connection.*

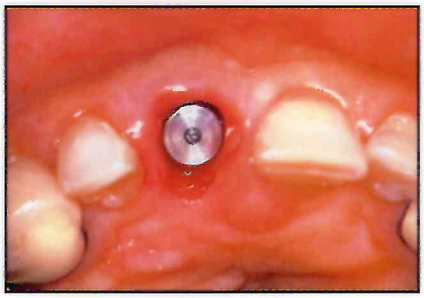


Fig 3c *Brånemark fixture with cover screw is implanted into the socket. Note the minimal tissue injury.*

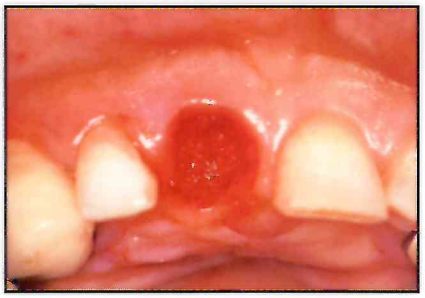


Fig 3d *Freeze-dried bone particles are placed on top of the cover screw.*

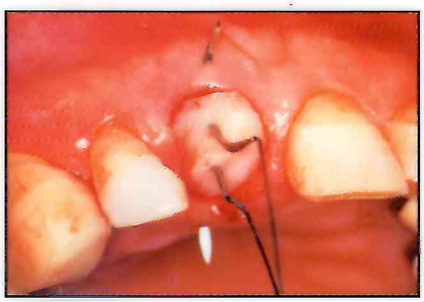


Fig 3e *Gingival autograft sutured to gingival walls of the socket. Note initial anchorage of graft by two needles.*

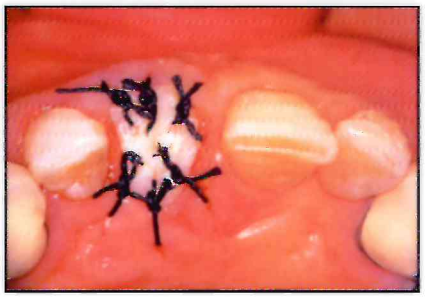


Fig 3f *Gingival autograft is secured into place by six simple sutures.*

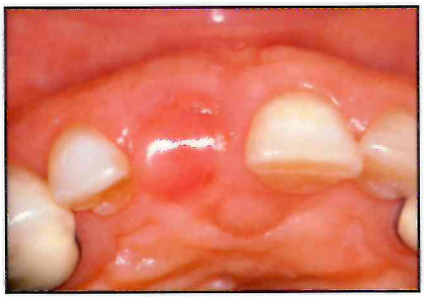


Fig 3g *Gingival autograft at 1 month. Note the complete seal of the socket and the adequate ridge topography.*

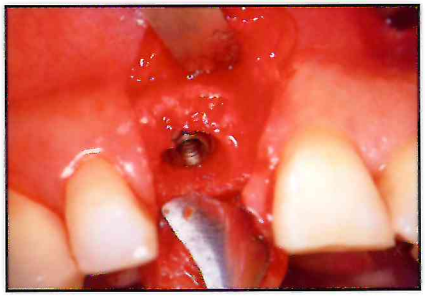


Fig 3h *Five months post implant placement. Note the adequate width of the ridge and the implant in optimal position.*

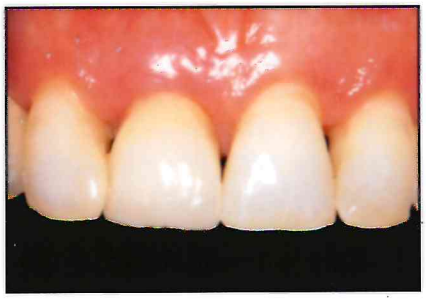


Fig 3i *Labial view of the restored ceramic crown. Note the natural crown appearance and adequate surrounding gingival tissue. (Prosthodontist: Dr I. Landsberg, Tel-Aviv, Israel; Dental Laboratory: Nobilceram, Tel-Aviv, Israel.)*

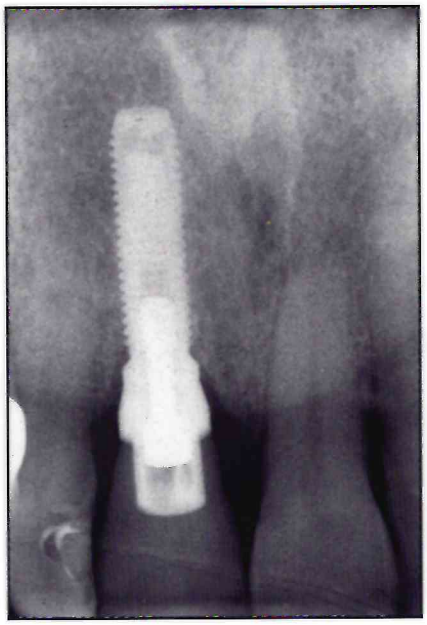
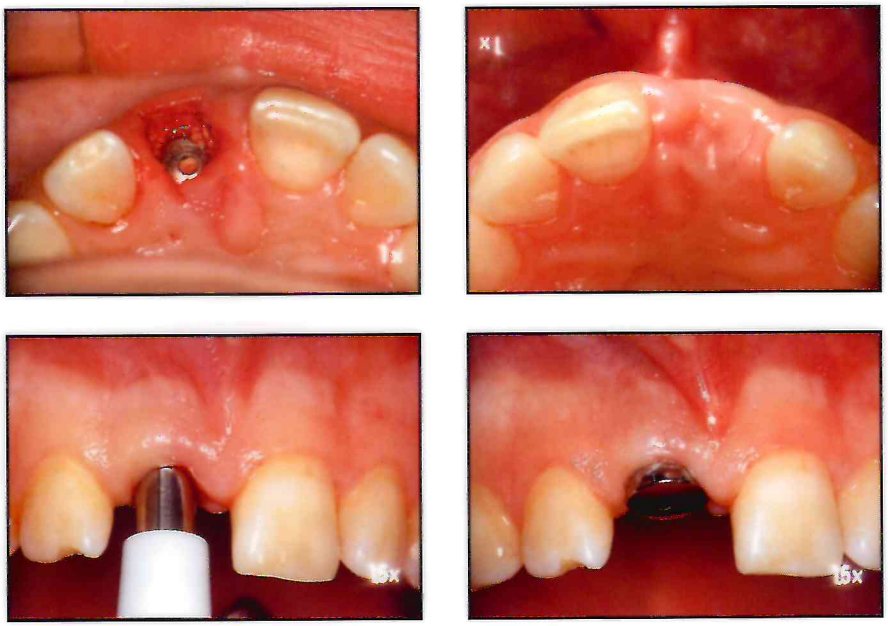


Fig 3j *Radiographic periapical view of the restored tooth. Note that the fixture appears to be well osseointegrated.*



Figs 4a to 4d (Top left) *Steri-Oss implant is inserted into the socket. DFDBA is placed between the implant and a thin labial plate.* (Top right) *Six months following implant insertion there is adequate ridge topography and a blending of the soft tissue graft with the surrounding mucosa.* (Bottom left) *Implant is exposed with a small diameter tissue punch. Note the adequate quantity and quality of the soft tissue.* (Bottom right) *Tapered healing abutment is connected to the implant to recontour the peri-abutment mucosa. Not minimal blanching of the compressed soft tissue.*

Case 3

An 18-year old woman presented with pain associated with a traumatized maxillary right central incisor. Clinical and radiographic examination revealed a vertically fractured root with a poor prognosis. After patient consultation, the decision was made to replace the root with an immediately inserted implant using SSS. The major steps performed are illustrated in Figs 4a to 4d.

Discussion

Socket seal surgery is a modified regenerative procedure performed immediately postextraction and is used mainly in the maxillary anterior region. It can be used prior to implant placement,[15] and, when followed by the cervical contouring concept[16] at the prosthetic phase, may achieve an optimal functional, phonetic, and esthetic result. The SSS may also be used with very satisfactory results for ridge preservation prior to conventional tooth-supported restorative cases. However, in implant cases, a 6 to 9 month postsurgery waiting period is required for the regenerated bone to mature and become suitable for implant placement.[15] To minimize the treatment period, it is advantageous to place implants directly into fresh extraction sites. It has been widely demonstrated that immediate implant placement may be predictably successful when "conventional" GTR techniques are used simultaneously with implant placement.[2-4,6,7,10-13] Different membrane barriers, such as e-PTFE,[2-13] collagen,[17] and others, have been used in this regard. Recently a modified approach was described in which autologous gingival grafts were used as "epithelial barriers" for guided bone regeneration in defects associated with immediately placed implants.[18] It was suggested that exclusion of flap epithelium from the wound area may be sufficient for bone promotion around the implant. In either case, relatively complex flap management is involved with subsequent loss of keratinized tissue and interdental papillary height, the restoration of which may require a challenging secondary plastic soft tissue surgery. In contrast, the SSS does not involve flap elevation, thus minimizing traumatic injury to the soft and hard tissue components of the socket and optimizing the preservation of ridge topography.

As described previously, a medium diameter implant is preferred as it may be localized level with the labial crestal bone, thereby minimizing the sulcular depth around the abutment and crown and optimizing the emergence profile of the crown. A smaller diameter implant is inferior in strength and may have to be localized too far subcrestally to allow the desired emergence profile of the crown, thereby increasing sulcular depth and compromising hygiene maintenance. A larger diameter (4.5 to 5.5 mm) implant may be superior, but the maxillary anterior ridge is usually too thin to contain it.

As shown, there are situations in which the implant may have fenestrated the buccal bone to a limited extent. If the periosteum at the fenestration site is only slightly lifted up by the implant with no significant injury, it may be assumed that there will be no significant negative impact on the osseointegration process and the final stability and long-term function of the implant. This assumption is supported by clinical documentation that demonstrates the possibility of lifting up the periosteum[22] or the Schneiderian membrane of the maxillary sinus,[23] following intentional penetration of the cortical bone by the implant apex without an untoward effect.

Autogenous bone graft or DFDBA, when placed around and on top of the implant, may be used to induce or conduce bone formation around the implant, maintain space under the gingival graft to maximize coronal bone regeneration, prevent collapse of the ridge when bony walls are thin and can resorb, or as a substrate for local delivery of growth factors.

The use of DFDBA in bone regenerative procedures has become controversial. Some clinical and histologic studies and case reports demonstrate the beneficial use of DFDBA prior to or simultaneous with implant placement, especially in naturally nonspace-making bony defects.[5,10-14] In contrast, other studies[19-21] claim no contributory or inhibitory effect of DFDBA on the regeneration process, especially in extraction sockets that are considered ideal defects for spontaneous

bone regeneration to occur.[19] When SSS is combined with immediate implant placement, the implant body significantly reduces the socket space, thus optimizing the bone regeneration potential around the implant. Therefore, and in light of the aforementioned studies, any additional currently available bone-promoting agents are probably unnecessary and preferably not to be used. However, in cases where the labial bone is thin and likely to resorb, it may be helpful to gently incorporate DFDBA particles or autogenous bone into the space between the implant and the labial wall, thus preventing the ridge from collapsing towards the implant.

To seal the socket orifice, a relatively thick gingival autograft containing part of the submucosa is used. The graft prevents implant site contamination, contains and protects the blood clot in the healing socket, and acts as a barrier against epithelial and connective tissue cells apparently as effectively as commercially available membranes.[15] It also augments the soft tissue component of the ridge, and in 5 to 6 months it seems to almost completely blend into the surrounding tissue. Second-stage surgery is usually performed 5 to 6 months post implant placement using a labially allocated crestal "miniflap" or a tissue punch to expose the implant head. A tapered healing abutment or provisional crown is used to optimize the crown emergence profile.

Advantages to the use of SSS in combination with immediate implant placement relative to conventional guided bone regeneration techniques that involve flap manipulation are as follows:

1. Implant may be ideally located since the soft tissue orifice of the socket dictates the exact desired position of the implant head.
2. Bacterial contamination may be more efficiently prevented because the surgical site is minimally exposed to the oral cavity.
3. There is no loss of keratinized gingiva at the buccal aspect of the implant site and the adjacent teeth.
4. Only negligible loss of interdental papillary height may occur.
5. There is no marginal gingiva recession at the adjacent teeth.
6. No labial mucosa scarring occurs.
7. Vestibular depth is not reduced.
8. Postoperative swelling and pain are minimal.
9. Second-stage surgery is involved with no or only minimal flap retraction and no untoward effects (no need for surgical membrane removal).
10. The procedure is significantly less time consuming than the conventional guided bone regeneration.
11. The treatment period from tooth extraction to implant loading is significantly reduced.
12. The procedure is less expensive (no need for a synthetic membrane).

A disadvantage relative to the use of membranes is that the SSS involves a secondary surgical site, the palate, to obtain the soft tissue graft.

The procedure may be performed in different clinical situations. However, the ideal and most predictable results are obtained when the surgical area is free of gingival inflammation, there is no periodontal or periapical pathology associated with the extracted tooth, the gingival socket and bony walls are intact and thick, and the basal bone apical to the tooth apex is of sufficient quantity and quality.

Although SSS may be performed in different areas of the mouth, it is mostly indicated in the anterior maxilla, where maintenance of ridge topography is of utmost importance for functional, esthetic, and phonetic reasons. Clinical and histologic studies are encouraged before this approach to immediate implant placement can be clinically implemented on a routine and predictable basis.

Acknowledgment

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