Indications for early implant placement with soft tissue healing (4–8 weeks)

The concept of early implant placement with soft tissue healing (type 2) was developed in the late 1990s. It requires a 4–8 week healing period following extraction before implants are placed. During this period, several biologic events take place which are in favor for the clinician and the patient, since they simplify the surgical procedure and reduce the risk for post-surgical complications. These advantages are as follows: (i) The soft tissues will spontaneously heal providing 3–5 mm of additional keratinized mucosa in the future implant site; (ii) the bundle bone will resorb, which mainly affects the mid-facial aspect of the extraction socket during the initial wound healing phase. This phase is dominated by a high osteoclastic activity resorbing the bundle bone delineating the extraction socket; (iii) in sites with a thin facial bone wall phenotype or in sites with a damaged facial wall, a spontaneous soft tissue thickening will take place. A recent study by Chappuis et al. (35) demonstrated a sevenfold increase of the soft tissue thickness in such situations in the mid-facial region. This offers several advantages for the surgeon including a thick mucoperiosteal flap for implant surgery, an enhanced vascularity in this flap improving the healing capacity, and a potential reduction of the need for connective tissue grafting for soft tissue augmentation; (iv) if present, acute or chronic infections or fistulae at the extraction site will resolve offering a future implant site with a reduced bacterial risk; and (v) at the apical portion of the socket, new bone formation will have taken place. This enables an easier implant bed preparation when compared with a fresh extraction socket.

The concept of early implant placement with simultaneous contour augmentation consists of a careful, flapless tooth extraction, a healing period of 4–8 weeks (depending on the size of the extracted tooth), and an open flap implant surgery using a triangular flap design (24). Here, a slightly palatal incision in the edentulous area is important, with the incision made along the inner surface of the palatal bone wall deep into the former socket allowing the entire regenerated soft tissue to be part of the buccal flap (Fig. 4A–C). This spontaneous soft tissue thickening has been documented recently in a clinical study with CBCT imaging by Chappuis et al. (35). This palatal incision technique offers a flap thickness of roughly 5 mm in the area of the former socket. Following flap elevation, blood is collected and stored in a sterile dish. Then, autogenous bone chips are locally harvested, either at the nasal spine with a flat chisel, or from the facial bone surface towards the canine fossa with a sharp bone scraper (Hu-Friedy, Chicago, IL). These bone chips are soaked in blood and stored in the sterile dish. Implant bed preparation follows to allow implant insertion in a correct 3D position and with a correct implant axis. For roughly 15 years, the concept of *comfort* and *danger zone*s has been used in daily practice (26). This includes an oro-facial position of the implant shoulder roughly 1.5 mm palatal to the future point of emergence, and a distance of 3–4 mm between the implant shoulder and the future mucosal margin on the mid-facial aspect. These distances have been determined for bone level implants, which are the standard of care for an implant supported single tooth crown in the esthetic zone. Bone level implants are based on the platform switching concept and show a better bone maintenance in the shoulder area of single tooth implants when compared with tissue level implants (32). Following implant insertion, a 2 mm healing cap is inserted and local contour augmentation is performed with the harvested bone chips to cover the exposed implant surface, and a superficial layer of deproteinized bovine bone mineral particles. Augmentation is done to the rim of the healing cap. Autogenous bone chips are used to accelerate new bone formation in the defect area, whereas DBBM particles are preferred for volume stability. Both synergistic characteristics have been documented with preclinical and clinical histologic studies (73–75). The augmentation material is then covered with a non-crosslinked collagen membrane (Bio-Gide®, Geistlich Biomaterials, Wolhusen, Switzerland). The membrane is cut into two strips, moistened with blood, and applied with a double-layer technique to improve membrane stability. At the end of surgery, a tension-free primary wound closure is achieved with non-resorbable suture material. For this, the flap must be released in most cases with an incision of the periosteum. Post-surgically, the existing provisional partial denture is shortened in the surgical site to avoid direct contact with the underlying tissues and delivered to the patient. The soft tissue wound healing takes roughly 2 weeks, whereas the bone healing period is typically set at 8 weeks. The implant is then exposed with a reopening procedure and the prosthetic rehabilitation is initiated. A typical case is shown in Fig. 5A–S.

This approach has been well documented in recent years. Mid-term studies have shown a low risk for mucosal recession, good to excellent esthetic outcomes (29, 53, 64), and a facial bone wall thickness of approximately 2 mm at 6–9 years of follow-up measured with CBCT imaging (21, 22).

Indications for early implant placement with partial bone healing (12–16 weeks)

This approach is used in patients when an extended peri-apical bone lesion is present, which does not allow implant placement in a correct 3D position

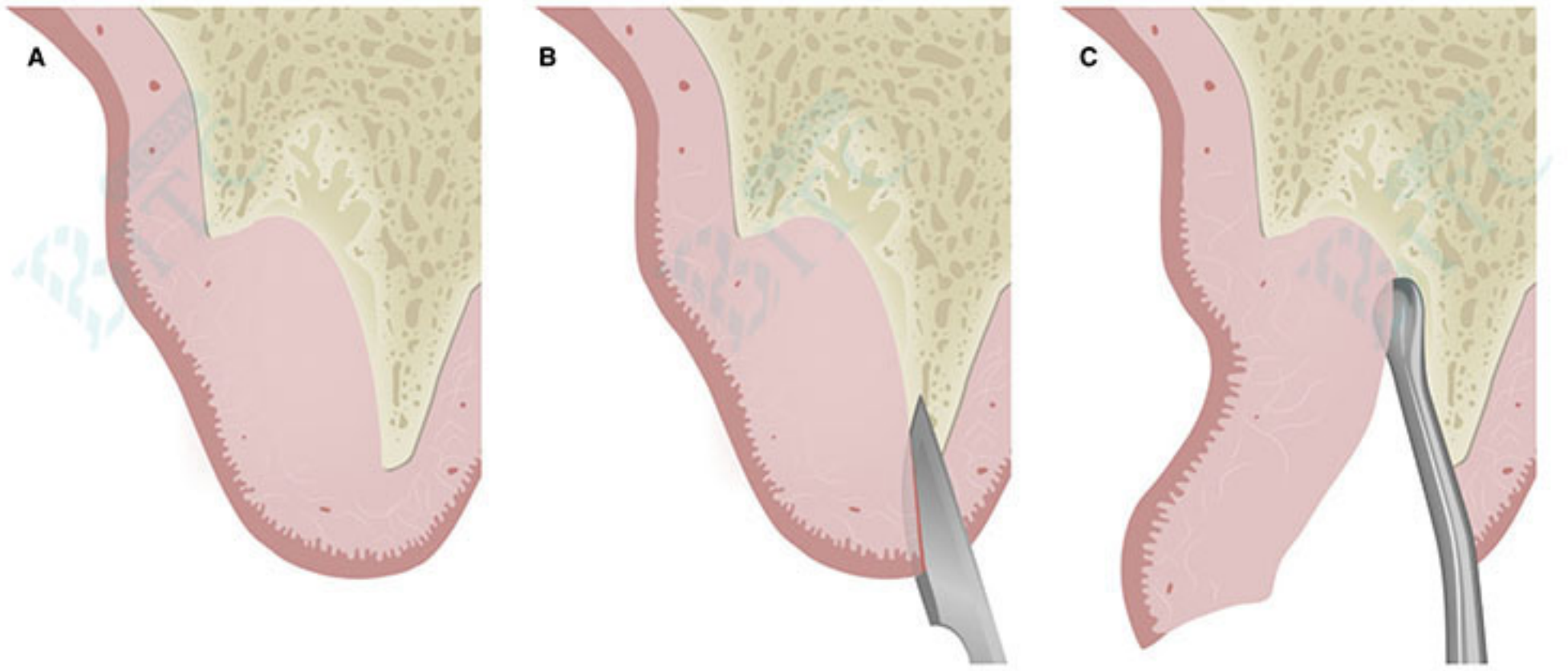
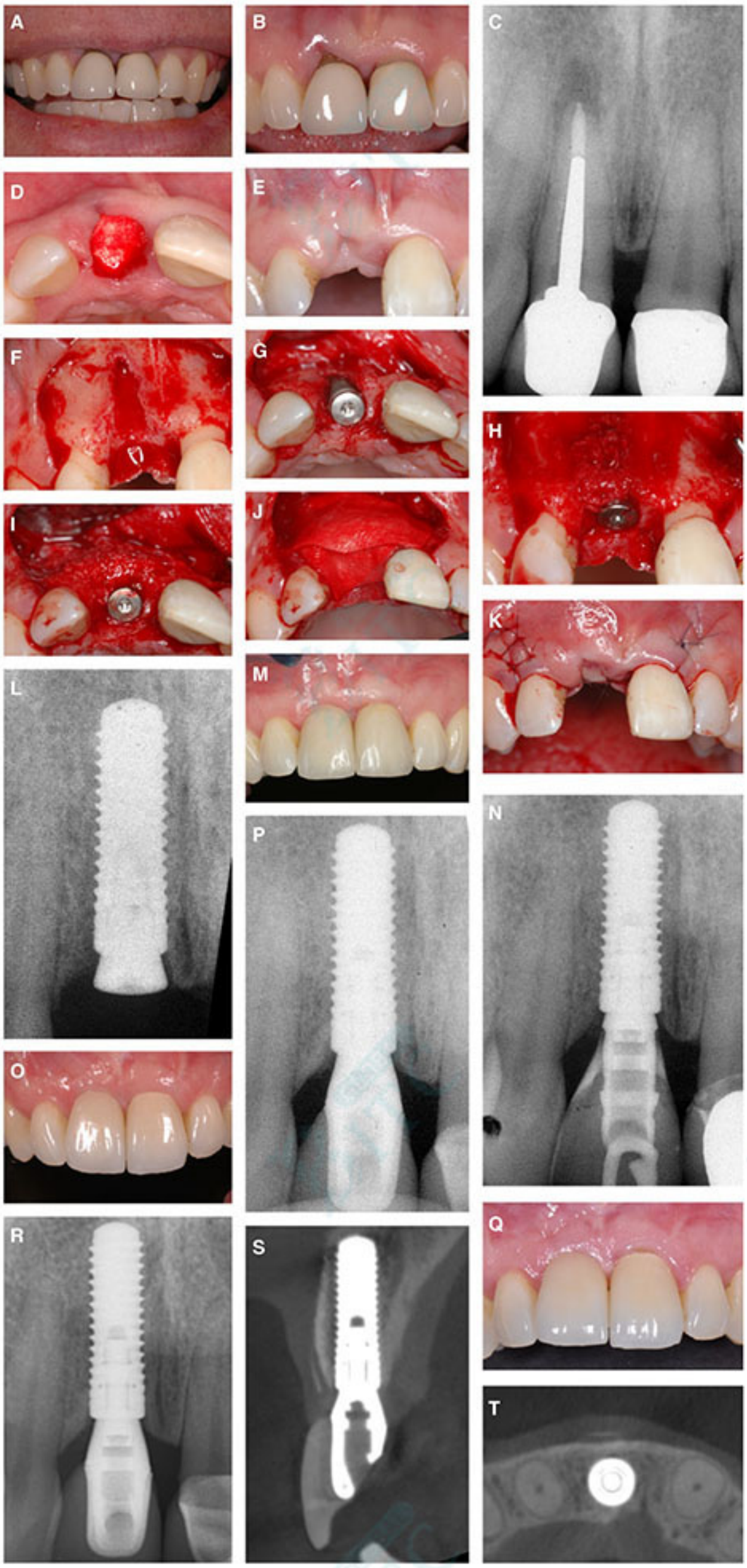


Fig. 4. (A) Schematic diagram in a sagittal, mid-facial section showing an extraction socket after 8 weeks of healing. The thin facial bone wall, mainly consisting of bundle bone, has been resorbed and a spontaneous soft tissue thickening took place by the ingrowth of soft tissue into the defect area. The facial aspect shows a slight flattening. (B) At implant surgery, 8 weeks post extraction, a palatal incision is carried out in this area, cutting with the blade along the inner surface of the palatal bone wall deep into the former socket. (C) With the help of a fine tissue elevator, the soft tissues of the former socket are mobilized as part of the mucoperiosteal flap to the facial aspect, offering a thick flap with excellent vascularity.

with sufficient primary stability with immediate (type 1) or early implant placement (type 2). These situations, which are rare in the maxillary anterior region, require a slightly prolonged socket healing period to allow for more new bone formation in the apical area. A typical case report is shown in Fig. 6A–C. It should be noted that early implant placement with partial bone healing (type 3) is ideal for the replacement of multi-rooted teeth, such as mandibular first molars.

Indications for late implant placement (≥ 6 months of healing post extraction)

From a patient's point of view, this is not an attractive treatment option, since a healing period post extraction of 6 months or longer is not what patients are asking for. However, there are indications for late implant placement and they can be classified into patient or site specific reasons (36). Patient specific reasons include most often young adolescent patients with trauma related tooth loss and of an age too young for implant therapy. Other reasons may be pregnant patients and patients being not available for implant surgery at an earlier time point for private or work related reasons. Site specific reasons include large apical bone lesions such as radicular cysts or ankylosed teeth in an apical position having insufficient bone volume available to stabilize the implant with immediate or early implant placement (Fig. 7A, B). In all these indications for late implant placement, the ITI strongly recommends performing a socket grafting post extraction as a ridge preservation procedure (88). There is ample evidence that socket grafting for ridge preservation is an effective surgical technique to significantly reduce ridge alterations and ridge atrophy post extraction (59, 69, 107). However, it must be noted that socket grafting with a low substitution rate filler such as DBBM cannot prevent bundle bone resorption during the first weeks of healing, which leads to some bone resorption in the crestal area of the facial aspect (2). The strategy of socket grafting is to avoid a ridge augmentation procedure at a later time point using a block graft combined with guided bone regeneration. Although this surgical technique is well documented and offers excellent and predictable regenerative outcomes (50, 108) and favorable long-term results (33), the technique is surgically demanding and causes an increased morbidity for patients, a long treatment time and two open flap procedures using a staged approach. With socket grafting post extraction, such staged ridge augmentation procedure can be avoided, although a simultaneous guided bone regeneration procedure is often still required at implant placement in esthetic sites to compensate for the crestal bone resorption which still takes places (2). Another viable treatment option to guided bone regeneration is the utilization of a connective tissue graft to compensate for this crestal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bone resorption under the condition that the implant is fully embedded in bone (56).

A typical case report of late implant placement with a 6-year follow-up is shown in Fig. 7A–R.

Conclusions

- The clinician today has the possibility to choose from four different treatment options for post-extraction implant placement. In the anterior maxilla, the esthetic outcome and its long-term esthetic stability is of paramount importance. This is the most important goal of implant therapy in these indications, followed by proper function and phonetics.
- Based on a much improved knowledge about tissue biology in post-extraction sites, well defined selection criteria are available today, to select the most appropriate treatment option. Today, all four treatment options can be recommended when these selection criteria are followed, but the four options are not used with the same frequency. The recommendations and typical characteristics of each approach are summarized in Table 2.
- Immediate implant placement (type 1) is the treatment of choice as a flapless procedure in sites with ideal anatomical conditions such as an intact facial bone wall with a thick wall phenotype (> 1 mm) and a thick gingival biotype. Under these strict selection criteria, this may represent 5–10% of single tooth extractions in the esthetic zone. For the patients, this approach is attractive, since it offers a low morbidity and the possibility of an immediate provisional prosthesis being delivered on the day of extraction. However, this approach is considered a complex procedure according to the SAC Classification [straightforward (S), advanced (A), complex (C)] and should therefore only be applied by talented, well-educated and experienced implant surgeons.
- Late implant placement (type 4) is only used, when it is absolutely necessary, since this is the least attractive option for the patient due to the long treatment period. To prevent a significant ridge atrophy, socket grafting with a low-

Fig. 5. (A) Lip view of a 42-year-old female with a high smile line exposing the gingival margins at the anterior teeth in the maxilla. The central incisors are both crowned for more than 10 years. She is very unhappy with the esthetic situation. (B) The close up view shows the right central with a gingival recession, inflamed gingival tissue and a deep pocket due to a root fracture. Both teeth are crowned. (C) The periapical radiograph depicts an apical bone lesion at the right central incisor, which has a long fracture of the root. (D) Clinical situation following careful tooth extraction without flap elevation. After tooth extraction, the socket is carefully debrided and rinsed, and filled with a low-price collagen plug to stabilize the blood clot. (E) The clinical status 2 months post extraction shows a clearly visible flattening of the ridge in the mid-facial area. The soft tissue are healed, the previously present acute infection is cleared. (F) During implant surgery (2006), the typical crater-like bone defect in the facial aspect is apparent all the way to the apical area of the former root tip. (G) The occlusal view shows a standard bone level implant (4.1 mm; Straumann) and a 2 mm healing cap. The implant is positioned about 1.5 mm palatal to the future point of emergence. The exposed implant surface is clearly located inside the bone providing a favorable 2-wall bone defect in the crestal area. (H) This bone defect is filled with locally harvested autogenous bone chips. These autografts have a high osteogenic potential and are supposed to accelerate new bone formation in the defect area during initial wound healing. (I) A second layer of bone filler is applied, DBBM particles with a low substitution rate. These fillers overcontour the ridge and provide long-term volume stability. (J) The augmentation material is covered with a non-crosslinked collagen membrane. The membrane acts as a temporary barrier to stabilize the applied bone fillers and to prevent the ingrowth of soft tissue cells from the overlying mucosa. (K) The surgery is completed with a tension-free primary wound closure. Please note that in 2006, a trapeziodal flap has been used. Today, a triangular flap would be utilized with only one releasing incision distal to the canine to avoid scar lines within the esthetic zone. (L) The postsurgical radiograph depicts the inserted bone level implant with the 2 mm healing cap. (M) After 8 weeks of uneventful healing, a reopening procedure was performed with a punch technique and a provisional crown inserted for soft tissue conditioning. The clinical view 4 months post implant placement shows a harmonious mucosal margin in the anterior maxilla. (N) The corresponding periapical radiographs depicts a well integrated bone level implant without any signs of bone loss at the implant shoulder. (O) Clinical status at the 1-year follow-up with the final crowns on both central incisors. The esthetic outcome is pleasing, the mucosal line is harmonious, the mid-facial mucosa in the correct position and the papillae well maintained. (P) The 1-year periapical radiograph confirms stable bone crest levels at this platform switching implant. (Q) At the 6-year follow-up (2012), the clinical status shows a stable mid-facial mucosa at the implant, whereas the natural tooth has developed a minor gingival recession of about 1 mm. In addition, the incisal edges indicate a minimal growth in the anterior maxilla, although female is now 48 years of age. (R) The 6-year periapical radiograph confirms again stable bone crest levels at the implant. (S) The 6-year CBCT shows in the oro-facial section a fully intact facial bone wall in an area, where there was no bone at all during implant surgery. (T) The horizontal cut confirms a correctly positioned bone level implant and a fully regenerated facial bone wall at the implant site.

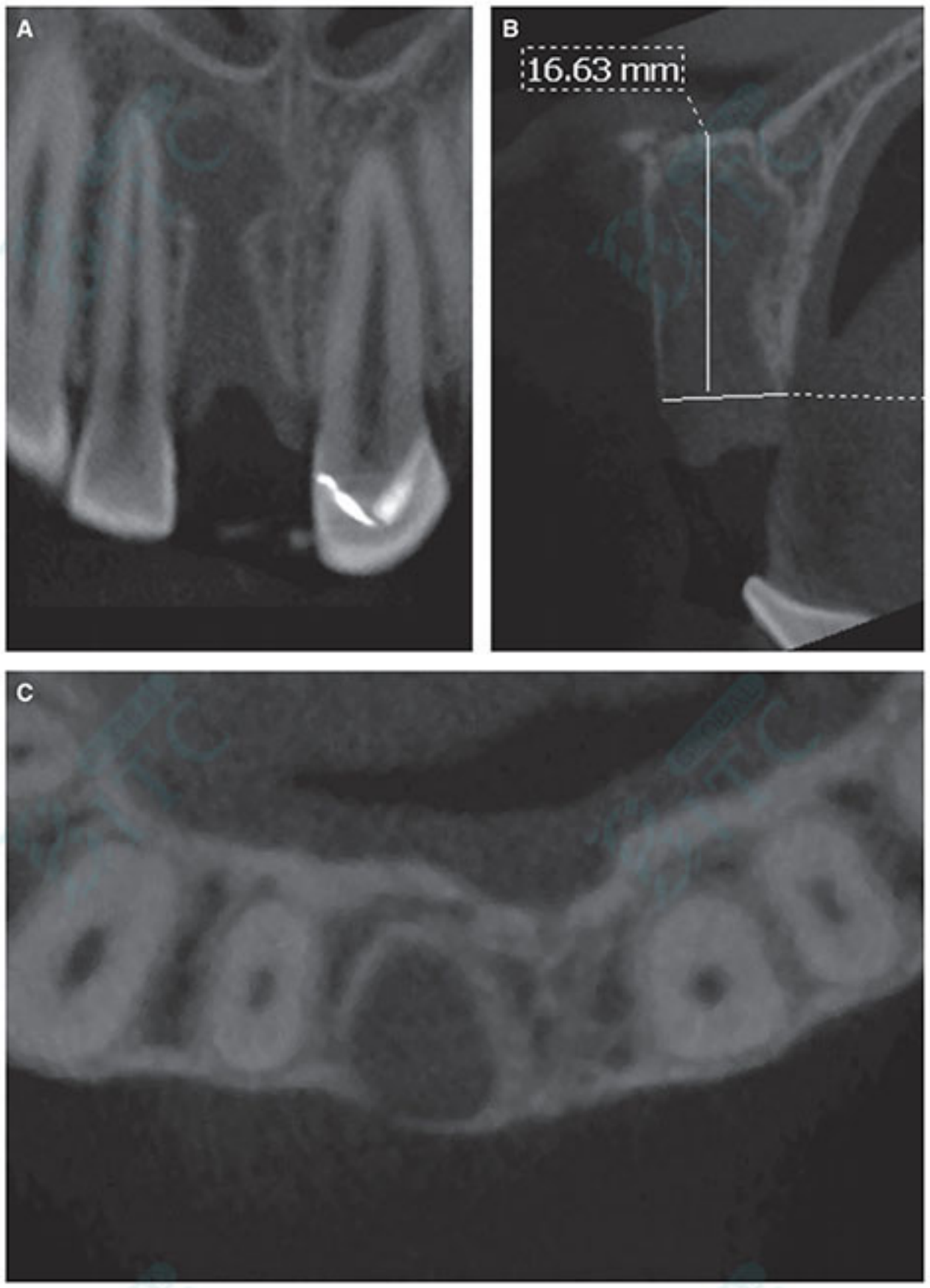

Fig. 6. (A) CBCT of an extraction sockets, roughly 4 weeks post extraction. A mid-size periapical bone lesion is apparent. (B) The oro-facial cut clearly shows a huge extension of this lesion towards the floor of the nose. Considering the distance of 16 mm to the nasal floor, the achievement of a sufficient primary stability is not feasible with type I & II placement. Thus, a prolonged healing period of 16 weeks was chosen prior to implant placement (type III). (C) The horizontal cut shows excellent crest width 3 mm apical to the CEJ (approximately 8 mm). Thus, implant placement will pose no problem with a type III protocol.

Fig. 7. (A) 32-year old female with subacute pain in the left maxilla and an elongated tooth 21, which was hypermobile and caused pain on palpation. (B) The CBCT shows a large cystic lesion apically to root 21. The floor of the nose is resorbed. The radiograph resembles most likely a radicular cyst. (C) Clinical status following extraction of tooth 21. Lots of cystic fluid pours out of the cyst, which is thoroughly rinsed. (D) Two months later, the cyst is surgically removed with a cystectomy and a simultaneous apicoectomy of the lateral incisor including a retrograde filling. (E) The occlusal view shows the really large bone defect following cystectomy. The facial bone wall of the former extraction socket has been resorbed during the 8 weeks healing period. The crest width, however, is excellent. (F) A ridge preservation technique is performed with autogenous bone chips, deproteinized bovine bone mineral particles and a collagen membrane to maintain the ridge volume for a later implant placement. (G) The augmentation material was covered with a collagen membrane. (H) The surgery is completed with a tension-free primary wound closure. (I) 6 months later, the site is reopened and late implant placement is performed into a nicely healed ridge of sufficient volume. A 3.5 mm healing cap is inserted. (J) The facial bone wall is again augmentated with a thin layer of DBBM particles to optimize the contour. (K) The bone fillers are covered with a double layer technique using a collagen membrane. (L) 2 months later, following a tension-free wound closure and a complication-free soft tissue healing, the single tooth gap shows a ridge with excellent volume. (M) Status following reopening with a punch technique shows the implant with a longer healing cap. The frenulum was also cut with a CO_2 laser. (N) The 6-year follow-up examination depicts a pleasing esthetic outcome with harmonious mucosal margins and no signs of a mucosal recession Acknowledgement: Dr Julia Wittneben Matter, Prosthodontist at the University of Bern, Switzerland. (O) The periapical radiograph depicts stable bone crest levels around the bone level implants.

substitution rate bone filler is strongly recommended. This approach is required in less than 5% of cases.

- Early implant placement with soft tissue healing (type 2) is used in sites with a thin or damaged facial bone wall, when the local bone anatomy allows a correct 3D implant position and good primary stability. Since these clinical conditions are often found at extraction sites in the anterior maxilla, type 2 placement is most frequently used by our group (> 80%). This approach offers good regenerative and esthetic outcomes with high predictability and a low risk of mucosal recession. It requires an open flap procedure when the soft tissues are healed to allow for a contour augmentation using guided bone regeneration.
- Contour augmentation is performed with locally harvested autogenous bone chips, to accelerate the rate of new bone formation, whereas biomaterials such as DBBM particles are used for volume maintenance over time due to its low-substitution rate. Resorbable barrier membranes such non-crosslinked collagen membranes are utilized to avoid a second open-flap procedure for membrane removal.
- Early implant placement with partial bone healing (type 3) is rarely used (1–3%), and only in sites with an extended bone lesion in the periapical area. Implant placement with simultaneous contour augmentation is identical to type 2 placement, but the treatment time is slightly longer.

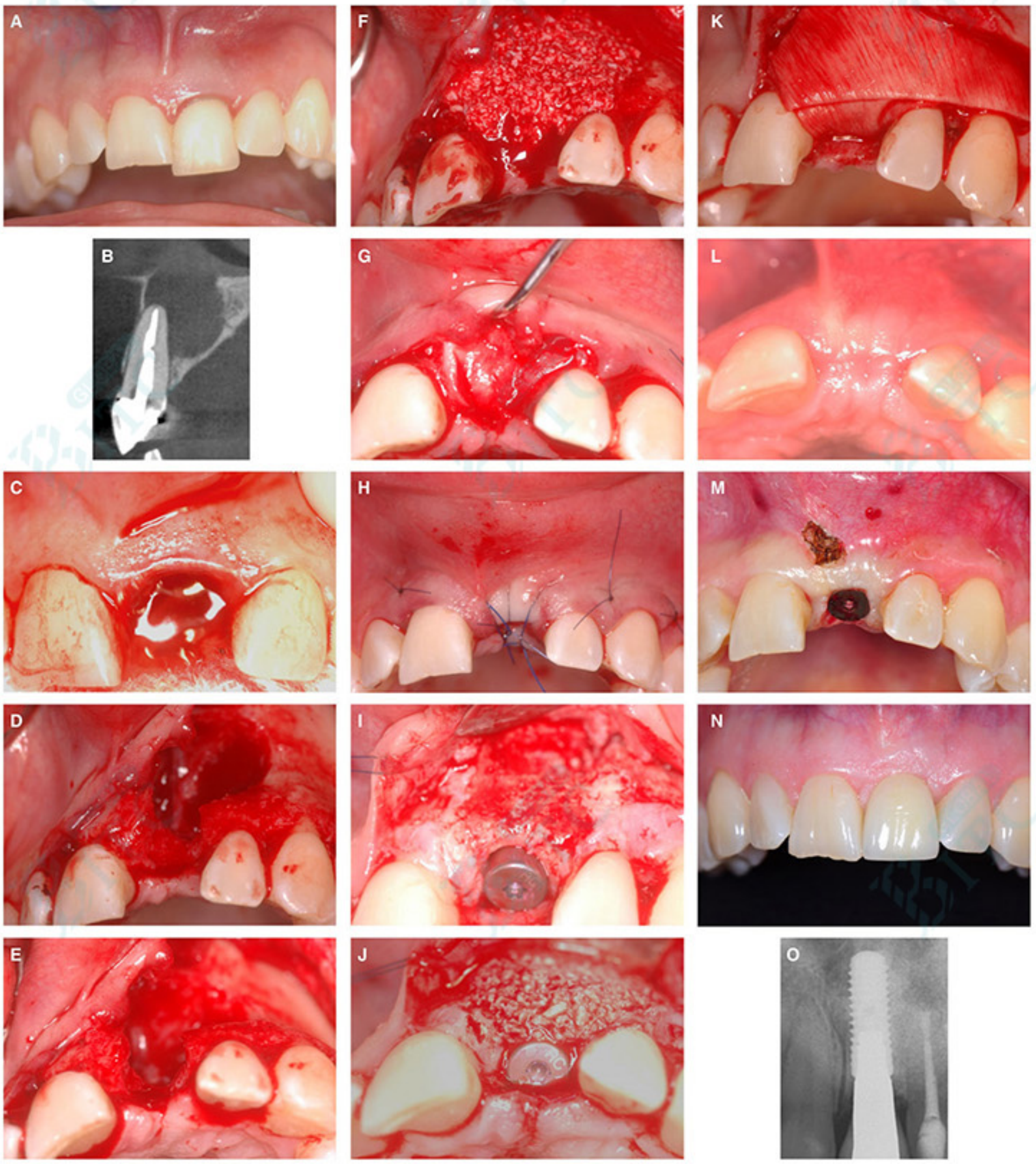

Table 2. Selection criteria and surgical aspects of each treatment option

Terminology	Immediate implant placement	Early implant placement with soft tissue healing	Early implant placement with partial bone healing	Late implant placement	
Classification	Type I	Type II	Type III	Type IV with prior socket grafting for ridge preservation	Type IV without socket grafting for ridge preservation
Healing period prior to implant placement	None	4–8 weeks	12–16 weeks	6 months or longer	6 months or longer (often years)
Selection criteria	Intact facial bone wall with thick wall phenotype (> 1 mm). Thick soft tissue biotype No acute infection in the socket. Sufficient bone volume apically to stabilize the implant in a correct 3D position	Thin or damaged facial bone wall Sufficient bone volume apically to stabilize the implant in a correct 3D position	Large periapical bone lesion which does not allow type I or II placement	Adolescent patients too young for implant therapy (age < 20 years). Extended bone lesions apical and palatal to the root. Ankylosed root in apical position without bone volume apically to the root	Extended delay in implant placement post-extraction for patient or site-related reasons
Surgical aspects	Flapless approach whenever possible Internal augmentation	Open flap procedure Contour augmentation with guided bone regeneration	Open flap procedure Contour augmentation with guided bone regeneration	Open flap procedure Contour augmentation with guided bone regeneration	If sufficient bone volume, open flap procedure and contour augmentation with guided bone regeneration. If insufficient bone volume, staged bone augmentation. Subsequent implant placement most often further grafting for contour augmentation
Difficulty level	Complex (Cat. C)	Advanced (Cat. A)	Advanced (Cat. A)	Advanced (Cat. A)	Complex (Cat. C)

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