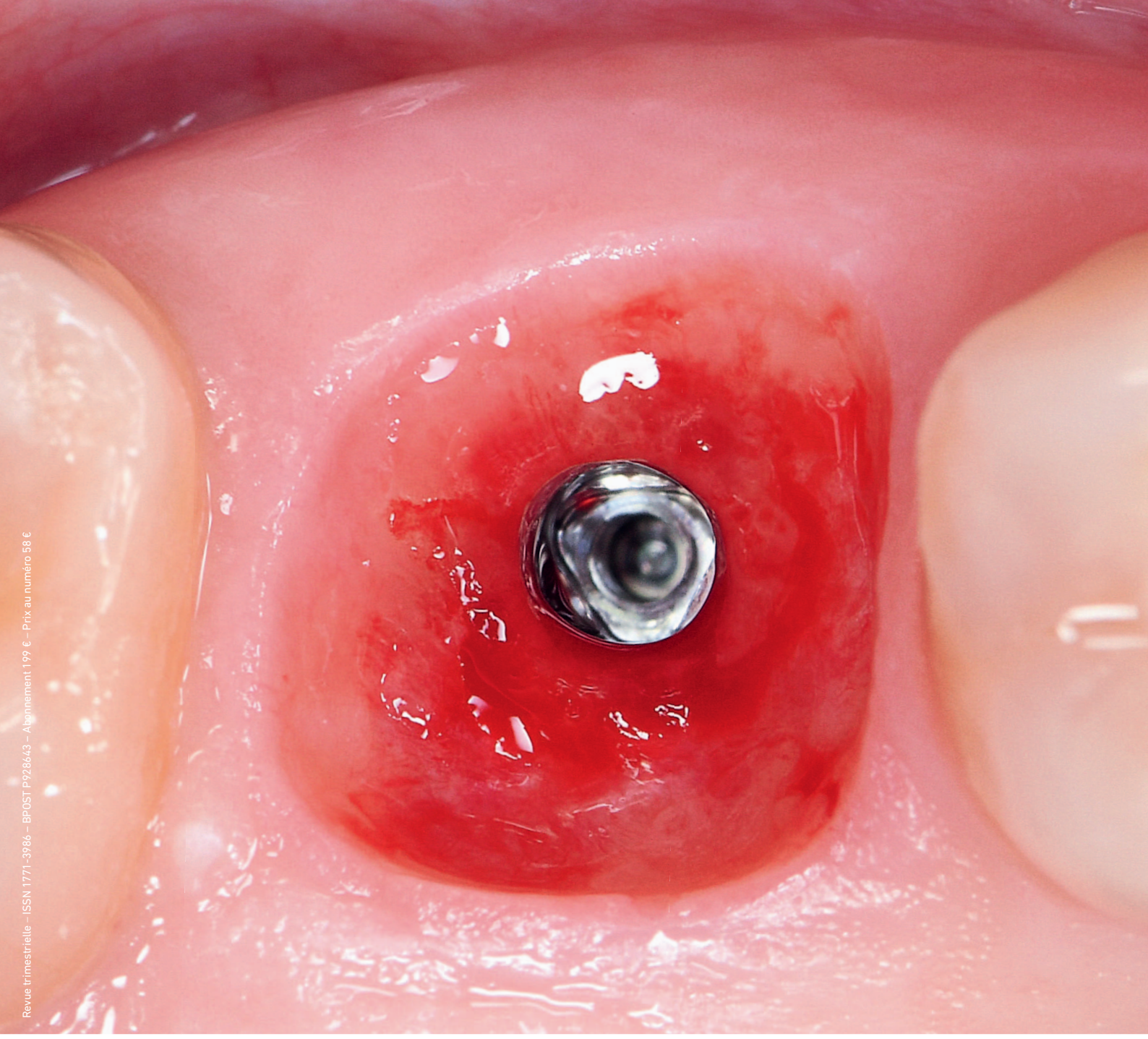

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Advantages of anatomic abutments

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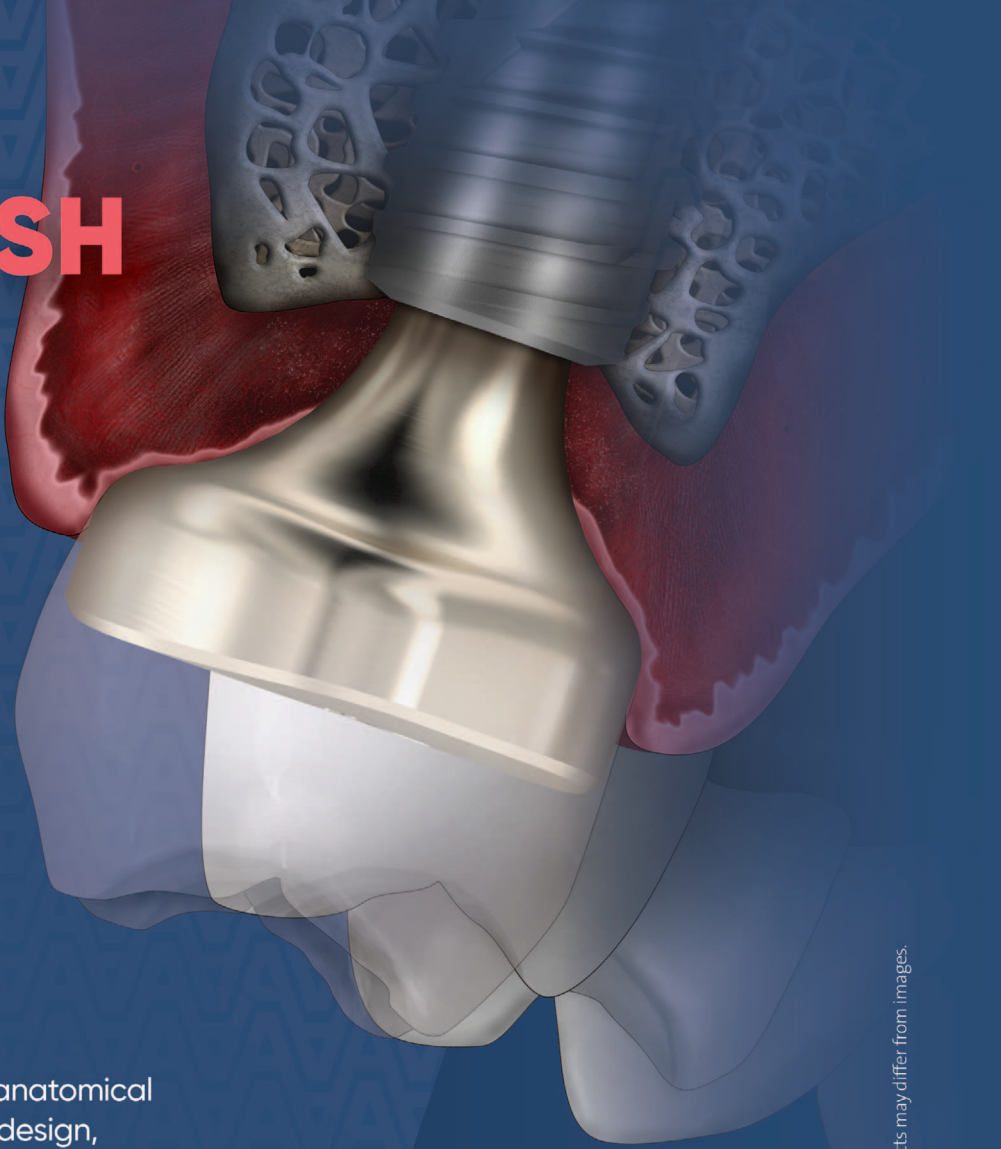

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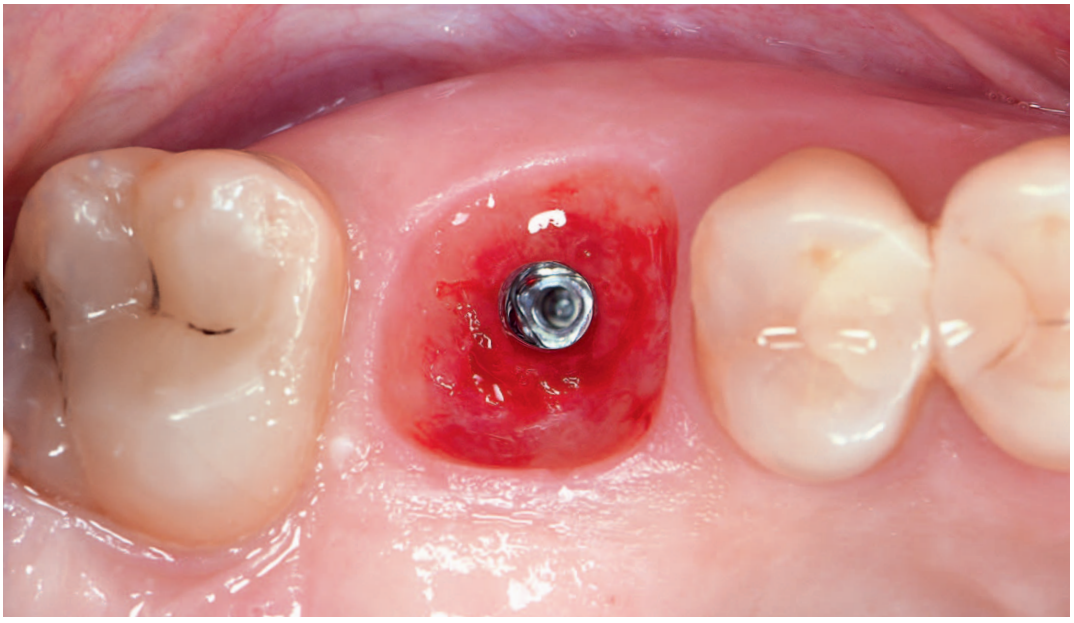

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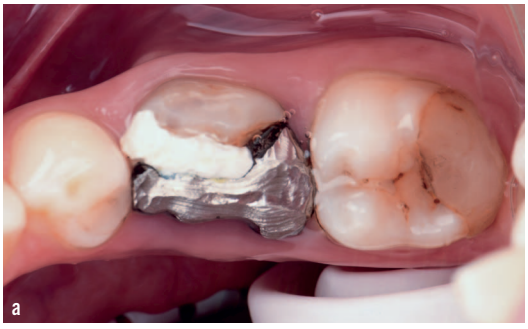
INTRODUCTION

Controlling resorption of the alveolar ridge after tooth extraction has been a major issue in dentistry for decades. Yet the volume of both hard and soft tissues must be preserved if we are to achieve a restoration that is in keeping with the current trend toward biomimicry.

This requires a good understanding of the complex, multifactorial process of remodeling that bone and soft tissues undergo after tooth extraction. It is well known in biology that "the function creates the body". The socket exists because there is a tooth. Remove the tooth, and remodeling is inevitable. The main reason to limit physiologic resorption is to retain as much bone as possible for the implant bed.

Doing so lets the implantologist position the implant to achieve a restoration that is esthetically and functionally suited to the patient. A loss of vestibular bone forces the implantologist to place the implant more palatally or lingually. Assuming the prosthesis has the usual size, this pushes the cervical portion out of alignment with adjacent teeth, causing significant discomfort during mastication due to food retention and potentially associated periodontal inflammation **(Fig. 1)**.



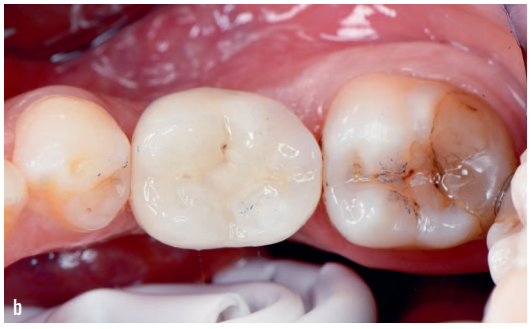


Fig. 1 a and b Vestibular bone loss owing to postextraction resorption.
(a) Bone volume before extraction. *(b)* After placement of the implant and crown.

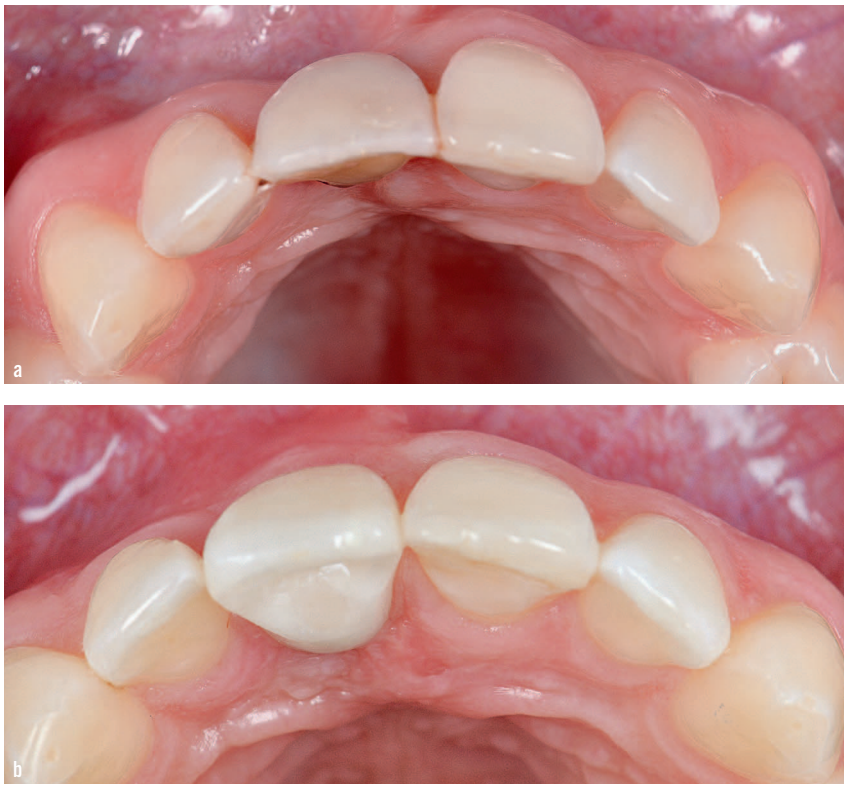


Fig. 2 a and b Reconstruction of vestibular bone and soft tissue in the anterior zone. *(a)* Horizontal resorption at tooth 11 following extraction several years previously and placement of a cement-retained bridge. (b) Resulting change in volume after bone and soft tissue reconstruction (before implant and crown placement).

Careful management of the extraction socket also limits the need for bone augmentation procedures. And if these are unavoidable, prior management of the extraction socket at least makes them more straightforward[1].

In the anterior maxilla, postextraction bone loss gives rise to problems of a more esthetic nature: either the vestibular gingival margins misalign vertically, or the interdental papillae collapse. Additionally, vestibular tissue loss disrupts the natural convex curve of the gingival arch in a transverse plane, leading to significant knock-on effects on esthetics. And when such loss occurs, restoring the gingival architecture of the anterior maxilla is challenging, both prosthetically and in terms of hard and soft tissue regeneration **(Fig. 2)**.

Hence if a tooth to be extracted is surrounded by significant hard and soft tissue volumes, every effort must be made to preserve it.

Numerous preservation techniques have been described in the literature. The two most common are socket preservation and immediate postextraction implant placement. Pre-extraction endodontic treatment and orthodontic extrusion are also both excellent techniques. However, their use is limited because they place certain constraints on both practitioner and patient, and because they make treatment longer.

PHYSIOLOGY OF THE POSTEXTRACTION SOCKET

The indication for a tooth extraction implies that either the tooth or the periodontium is diseased.

An infection of the alveolar bone usually leads to destruction of this tissue. The exact location of the bone defect depends on its etiology, be it endodontic, periodontal, a root fracture, internal or external resorption, or even a combination of these. To avoid errors of bias, some studies involving human subjects have only studied alveolar outcomes if teeth were extracted due to (i) orthodontic reasons or (ii) a significant loss of coronal tissue that made restoration impossible[2].

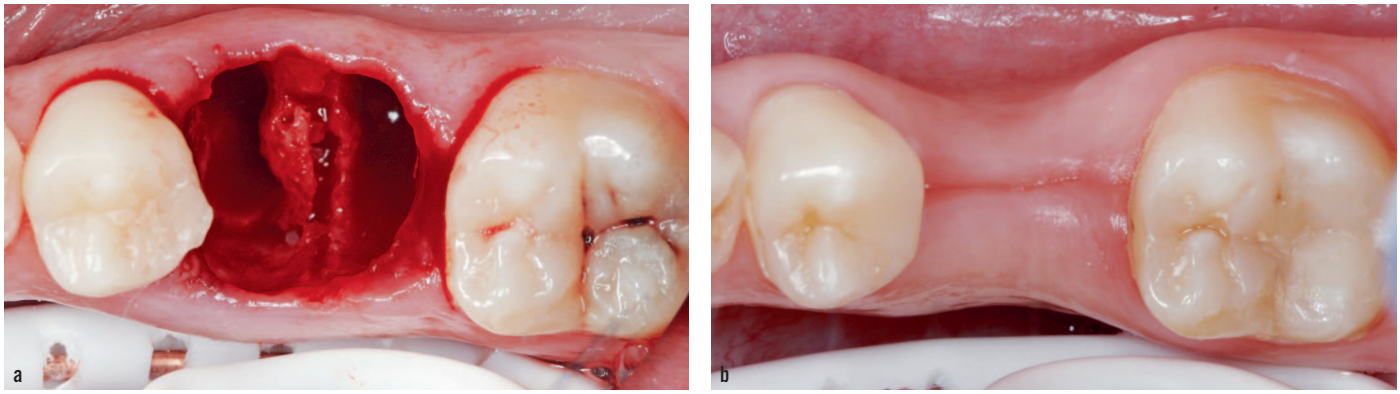


Fig. 3 a and b Postextraction resorption without socket preservation.
(a) Extraction socket.
(b) 3 months after extraction.

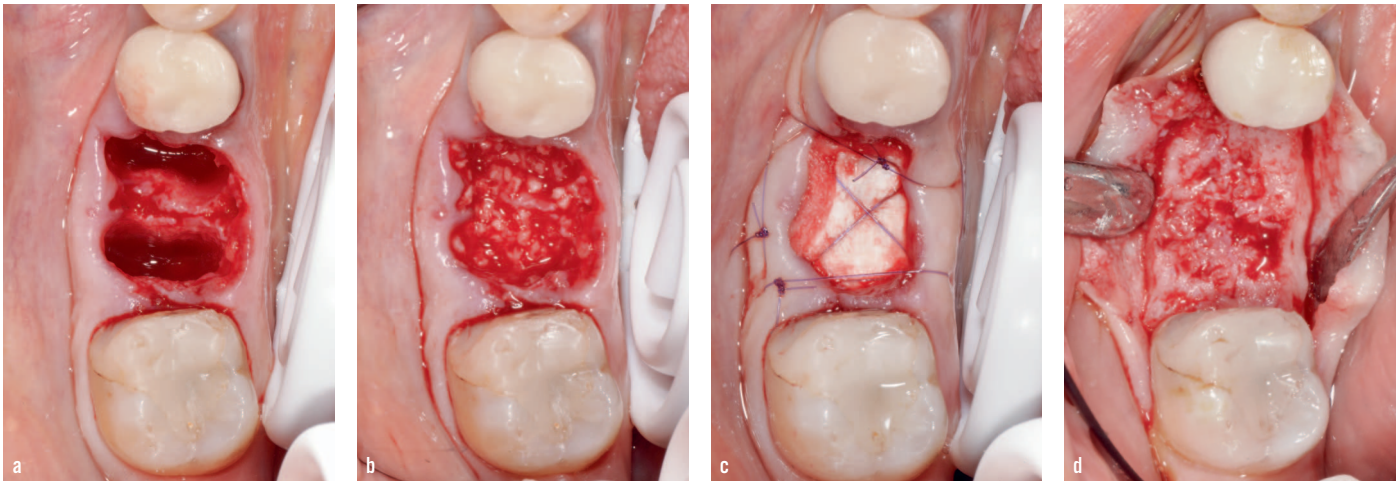


Fig. 4 a to d Socket preservation using an allogenic bone graft (BIObank®). *(a)* Extraction socket. *(b)* Socket filled with allogenic bone graft. The graft is protected with a collagen sponge. *(d)* Bone healing at 4 months.

Physiologic resorption was observed in these four walls defects. The removal of a tooth and its highly vascular periodontal ligament influences the postextraction bone remodeling results. This phenomenon has been widely described in the literature, both in humans and animal models[3,4]. Horizontal and vertical losses are in the range of 50% and 15% respectively. However, the results of these studies were highly variable, possibly due to the large number of factors that affect resorption, including anatomic location, cortical thickness, extraction technique, and initial pathology.

Vestibular cortical bone resorption is greater in both the mandible and the maxilla, probably because the vestibular bone is thinner and the vestibular muscle fibres rub harder against it[5] **(Fig. 3)**.

SOCKET PRESERVATION

The extraction socket shall be conceived as a two-stage process for the hard and the soft tissue.

Filling an extraction socket with biomaterial is a straightforward procedure for a practitioner. But depending on the clinical situation, extracting a tooth may prove a far more delicate operation. "Atraumatic" extraction encompasses all surgical techniques used to extract a tooth without damaging the alveolar process. The recommended approach is to divide or section the roots and use gentle rotation to remove the tooth without fracturing the investing bone. Grinding away the surrounding bone should only be used as a last resort if there is no other way of elevating the root. Once the tooth has been removed, the socket must be carefully curetted to remove all granulation tissue. The initial pathology of the extracted tooth determines how much curettage is needed. This step can, however, also be made difficult by the size and location of the lesion.

The socket is then rinsed abundantly so that socket preservation may begin. The choice of material is always crucial. The data in the literature are of some help, but clinical observation of the final outcome is a surer guide. This outcome should be judged in terms of the quality and quantity of remodeled bone, as well as of the time necessary to achieve it.

Allogenic bone grafts (BIObank®) resorb faster. This ensures better osseointegration and reduces the time a patient must wait before implantation (around 4 months). Xenografts (Bio-Oss®), on the other hand, take longer to achieve the same level of osseointegration (6 to 8 months), although their low resorbability gives them an advantage in preserving bone volume[6] **(Fig. 4)**.

The next point to consider is how to seal the socket[7].

For the very best results, connective tissue grafts and free gingival grafts are still unequaled. They augment the crestal area, thereby partially offsetting vertical alveolar resorption. They also seal the extraction socket and promote better healing of the crestal portion of the bone graft. Clinically, this leads to more cortical bone in the crestal region—a scenario highly unlikely without a gingival graft. Socket sealing may also be performed with a circular free gingival graft or with

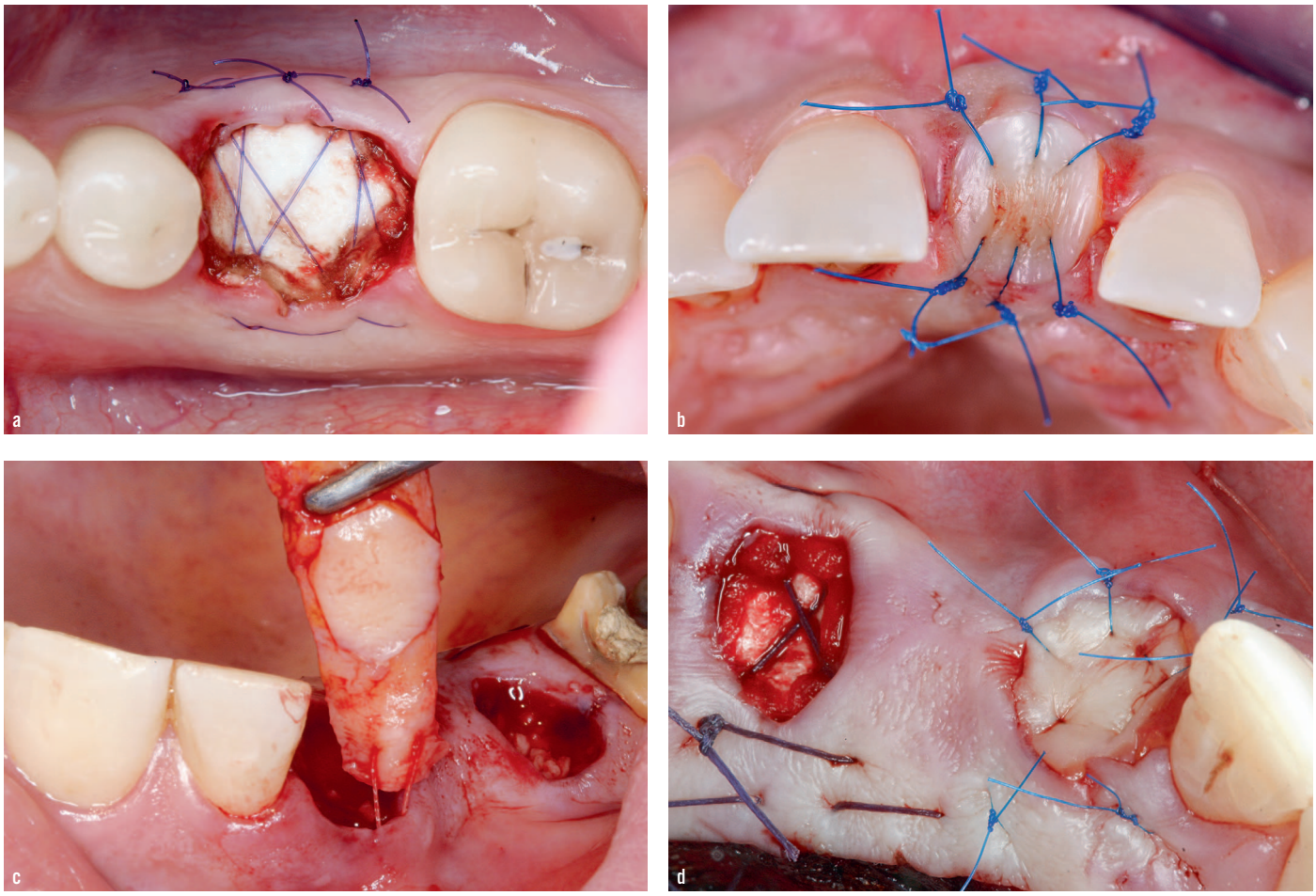


Fig. 5 a to d Techniques for sealing the extraction socket after filling. *(a)* Collagen sponge. Circular free gingival graft obtained using the punch technique. *(c and d)* Placement of a combined free gingival/connective tissue graft at site 13.

a combined free gingival/connective tissue graft. (The last mentioned may also be employed to augment the vestibular and palatal surfaces.) An additional approach is to use a pedicle graft obtained by rotating the inner portion of the palatal flap[8,9].

Alternatively, the socket can be simply sealed with a collagen sponge. The sponge protects the graft material and keeps it in place for the first days after the procedure until the blood clot, and the fibrin it contains, can take over. Obviously, performing an extraction and a gingival graft at the same time makes the procedure complicated and, consequently, more operator-dependent. This is why the above option is usually only used in the anterior maxilla, where esthetics are primordial.

It is not recommended to seal the socket using a coronally positioned vestibular flap. Doing so displaces the mucogingival junction coronally, thereby diminishing the keratinized tissue available to act as a vestibular barrier[10] **(Fig. 5)**.

Time to implantation depends on the choice of grafting material. Any soft tissue that is present in the crestal region may prove useful for soft tissue augmentation during implantation or second-stage surgery. The decision to submerge or not to submerge the implant mostly depends on whether a second surgical stage is needed to augment soft tissue thickness.

Although immediate non-occlusal loading is possible in a site that has been filled with grafting material, immediate *occlusal* loading is a decision that must be weighed far more carefully.

Grafted bone simply does not have the same tolerance as native bone–especially if a biomaterial is used.

IMMEDIATE POSTEXTRACTION PLACEMENT

If the patient's situation permits it, immediately placing the implant in the socket right after extraction is an alternative technique that has multiple advantages[11].

One factor that determines the success of immediate placement is that all four socket walls be intact. This especially applies to the vestibular wall, it being the thinnest. An essential component in primary implant stability is the presence of a bony septum and/or adequate apical bone. Note, however, that placing the implant does not in itself prevent alveolar resorption[12,13]. Indeed, the way to maintain hard and soft tissue is to fill the space in the alveolar socket around the implant with grafting material and to seal the socket with an anatomically appropriate technique[14]. In the anterior zone, immediate non-occlusal placement of a temporary restoration gives the patient an immediate fixed and esthetic solution without having to wait for an esthetic result. Restriction of certain foods is required for the first few months to limit micro-movements and thus ensure osseointegration.

This temporary restoration supports and guides the soft tissues as they heal around the restoration's anatomic form. The success of this protocol lies in correct 3D implant positioning, peri-implant socket preservation, soft tissue management in the transmucosal zone, and placement of a temporary restoration of suitable contours.

In such settings, angle correction on both the temporary and final prosthesis is of great help (AxIN®, Anthogyr). With angle correction, the implant can be inserted so that its axis aligns with the anatomy of the alveolar bone, and the screw access channel of the prosthesis can be placed palatally[15] **(Fig. 6)**.

CLINICAL CASE 1 Immediate postextraction placement in the anterior zone

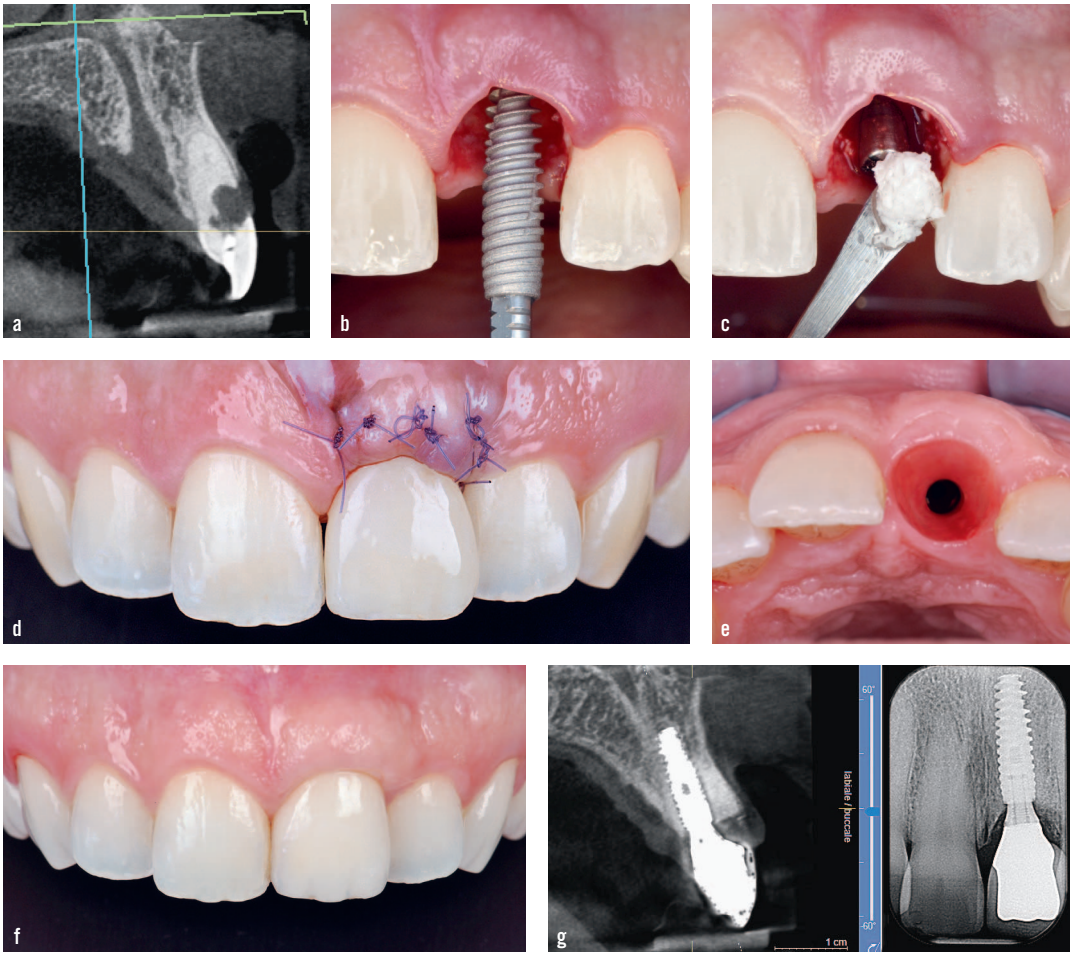


Fig. 6 a to g *(a)* Root resorption makes extraction necessary. *(b)* Implant placement. *(c and d)* Insertion of grafting material between the vestibular socket wall and implant surface (Bio-Oss® xenograft). Vestibular connective tissue graft and immediate temporary restoration. *(e)* Emergence profile 4 months after surgery. *(f)* Vestibular view of the final crown. *(g)* Radiologic follow-up 1 year after surgery.

In the posterior zone, the criteria are slightly different. Even though esthetics are not the primary concern in posterior teeth, immediate placement still plays a role in preserving hard and soft tissue volume.

As with single-root teeth, placing the implant, preserving the extraction socket, and sealing the socket with an anatomic component ensures optimal preservation of original tissue volumes[16,17].

This protocol non only enhances esthetics through easier alignment of the cervical margins but also improves the overall function as the implant can be placed more centrally. And because there is no concavity in the cervical portion of the prosthesis and surrounding tissues, food is less likely to become trapped during mastication.

Of course, it is difficult to gauge how much of the final outcome is due to the influence of the implant, the anatomic abutment, and socket preservation. Based on our clinical experience—and here the literature corroborates our observations—the implant plays no part whatsoever in tissue preservation. Its only role is to provide a stable platform for the abutment that seals the extraction socket. Whereas the anatomic abutment and socket preservation are crucial to the final outcome **(Fig. 7)**.

It should be noted that placing an implant in a posterior extraction socket remains technically challenging. Inserting an implant into an interradicular septum or septa requires careful, precise use of instruments by the practitioner in these anatomic structures. It is common for the implant to deviate from the planned insertion axis if a section of the septum ruptures.

For this reason, careful analysis should precede any decision to perform immediate implant placement in a molar. Molars with diverging roots and a short root trunk are the best candidates. The anatomy of the maxillary and mandibular first molars is thus better suited to immediate implant placement than that of the second molars, whose roots are closer together and diverge further distally. Bear in mind that this is not a hard-and-fast rule for immediate implant placement in molars. In some clinical situations, it is better to simply delay implant placement.

Anatomic abutments come in a number of options. There are standard anatomic abutments like those by iPhysio®, Anthogyr®, Cervico®, and Biotech Dental®. The clinical outcome with these depends on choosing the abutment with the right form. An anatomic abutment may also be custom-made, either chairside as a sealing socket abutment[16] or before surgery as a pre-milled anatomic component (Simeda®, Anthogyr).

Fabricating a sealing socket abutment intraoperatively does take time. There is also the handling of the prosthesis to be considered. In this light, switching to a standard or custom pre-milled anatomic abutment is a worthwhile alternative, as it

CLINICAL CASES 2 AND 3 Immediate implant placement in the posterior zone using a sealing socket abutment

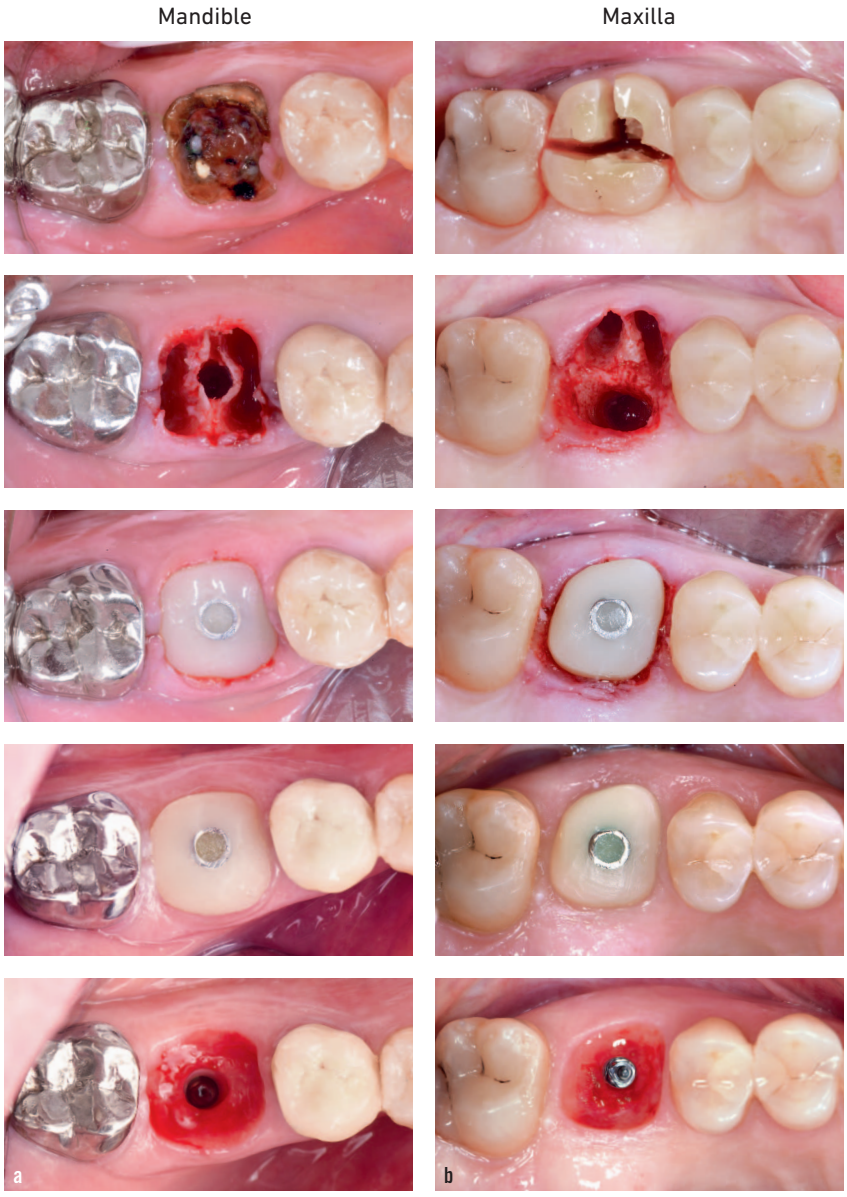
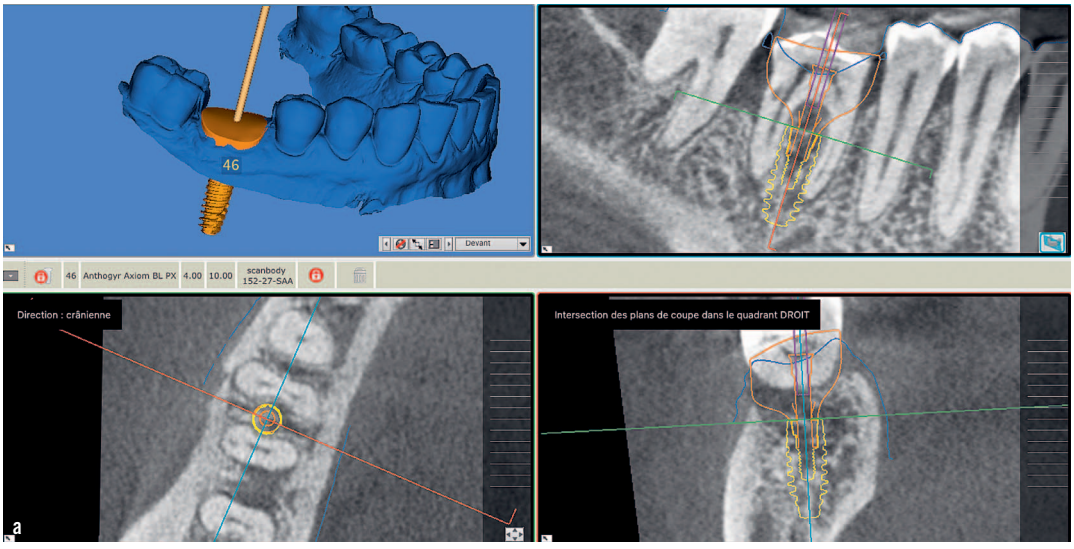
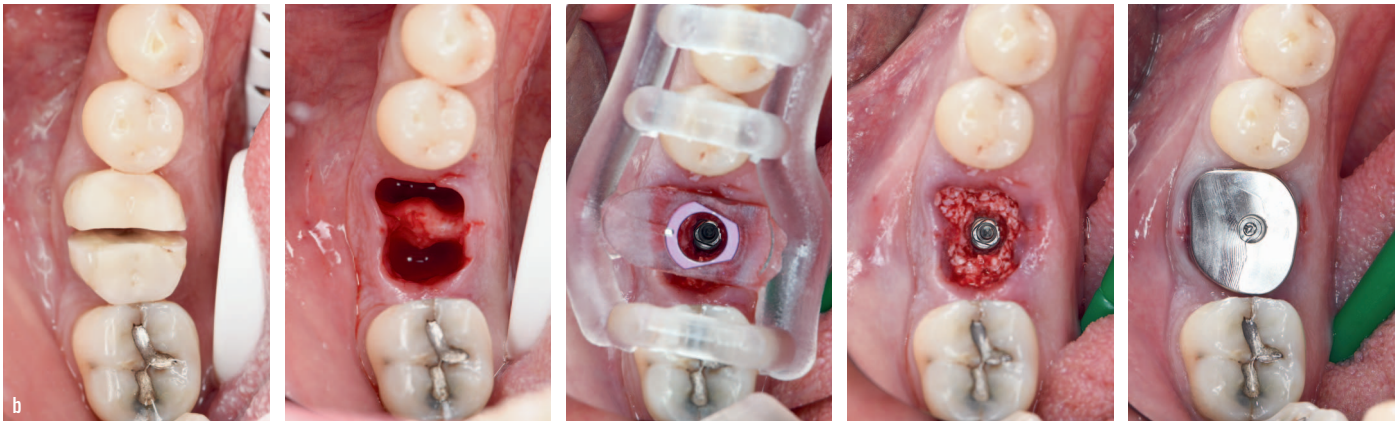


Fig. 7 a et b

can save time and help maintain surgical asepsis. If custom-milled anatomic abutments are used, they must be incorporated directly into the initial digital implant treatment plan. The plan is then sent to the prosthetic lab, which designs the abutments so that they are ready for milling in a milling center (Simeda®, Anthogyr). Using this approach, the practitioner has a surgical guide and a custom anatomic abutment ready to go on the day of the extraction **(Fig. 8)**.

CLINICAL CASE 4 Immediate implant placement in the posterior zone using a custom-milled anatomic abutment





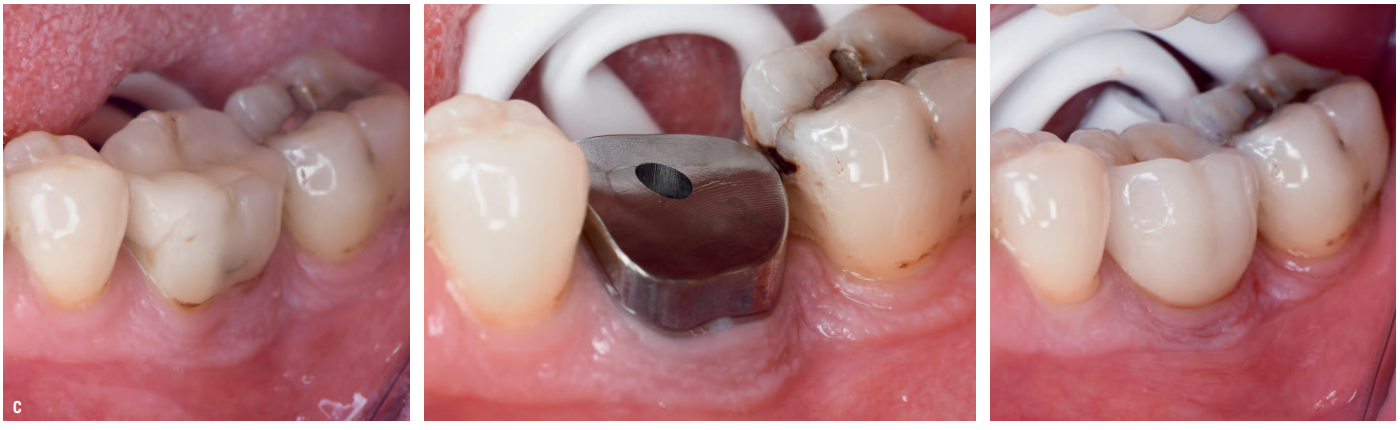


Fig. 8 a to c
(a) Treatment planning. *(b)* Atraumatic extraction preserves the socket walls and septum. A surgical guide is used to place the implant, and then a custom-milled anatomic abutment is inserted. *(c)* The periodontal tissues and initial cervical contours are preserved using a custom-milled anatomic abutment.

The anatomic abutment does more than just guide peri-implant tissue preservation with its anatomic contours. It can also be scanned like a scanbody, and so can mark the position of the implant and emergence profile while taking an optical impression. The practitioner simply unscrews it when the time comes to place the crown. This approach greatly simplifies the protocol, both from a prosthetic and a biologic standpoint.

The alternative to customization could be a standard anatomic abutment. The latter also has its advantages. Although it does not conform to an ideal cervical contour, standard anatomic shapes could maintain the periodontal tissues in their original position. Thanks to the healing process and to the formation of a blood clot during surgery, the implant's emergence profile conforms to the cervical anatomy of the tooth that it replaces. *Conversely,* a circular healing abutment—no matter how wide—cannot guide soft tissue remodeling adequately to achieve a prosthetic rehabilitation that perfectly reproduces the function and esthetics of the original tooth **(Fig. 9)**.

CLINICAL CASES 5 AND 6 Emergence profile remodeling after implant placement

Healing abutment *VS* Anatomic abutment

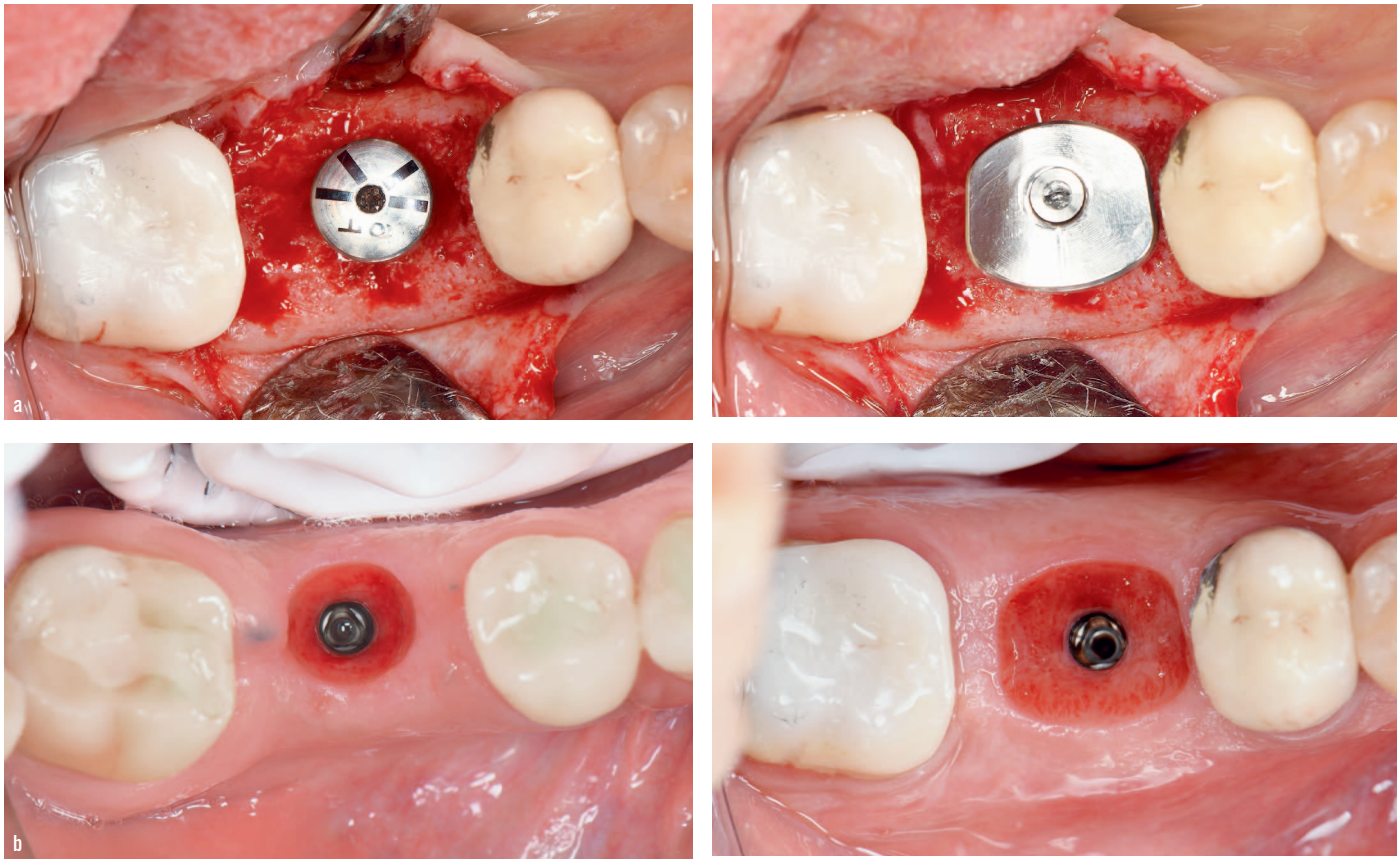
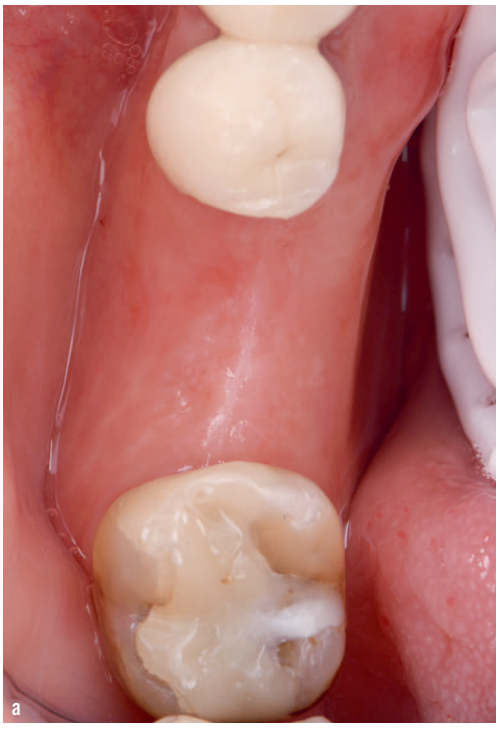
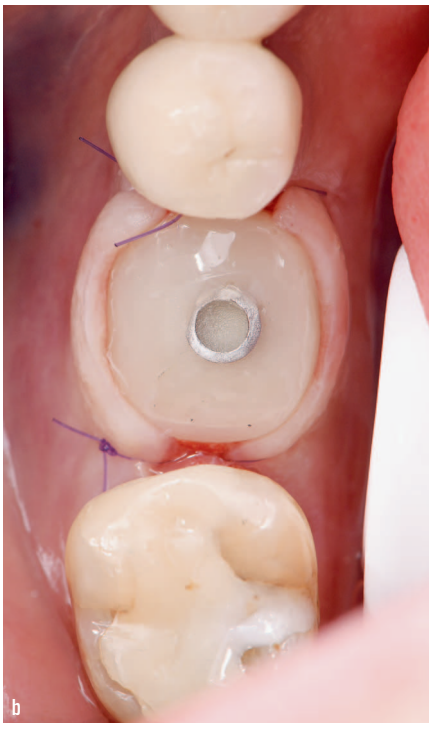
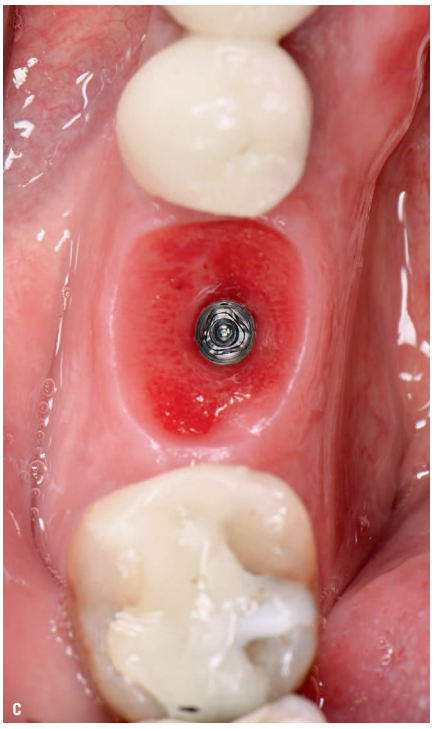


Fig. 9 a and b

CLINICAL CASE 7 Emergence profile remodeling with delayed implant loading



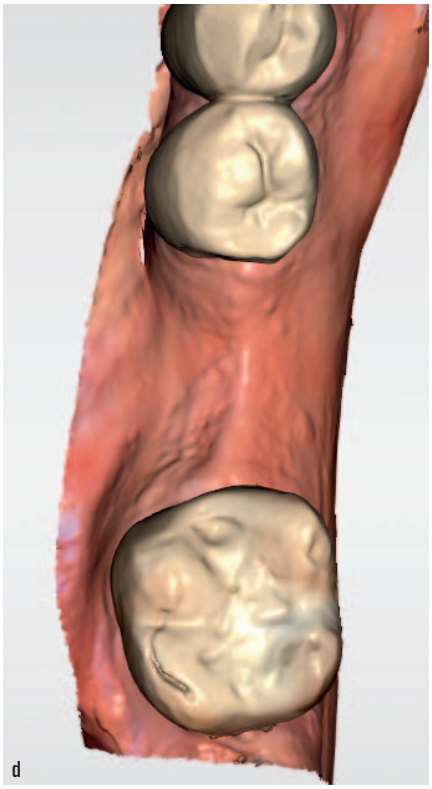




UTILITY OF ANATOMIC ABUTMENTS IN DELAYED PROTOCOLS

The utility of anatomic abutments extends well beyond the narrow boundaries of immediate postextraction placement. Indeed, anatomic abutments are also helpful when placing implants in a healed ridge **(Fig. 9)** or during second-stage surgery. Once again, it's the healing process combined with the use of an anatomic component that produces the result.

A cylindrical emergence profile that has already healed is especially tough to modify, even if we subsequently employ an anatomic component. This is why the role played by the blood clot in the healing process matters just as much as the contours of the material protecting it. Usually, a single, crestal incision will split the keratinized tissue. The anatomic component then keeps the keratinized tissues apart, allowing the blood clot to occupy this space and fulfill its healing function over the ensuing weeks **(Fig. 10)**.



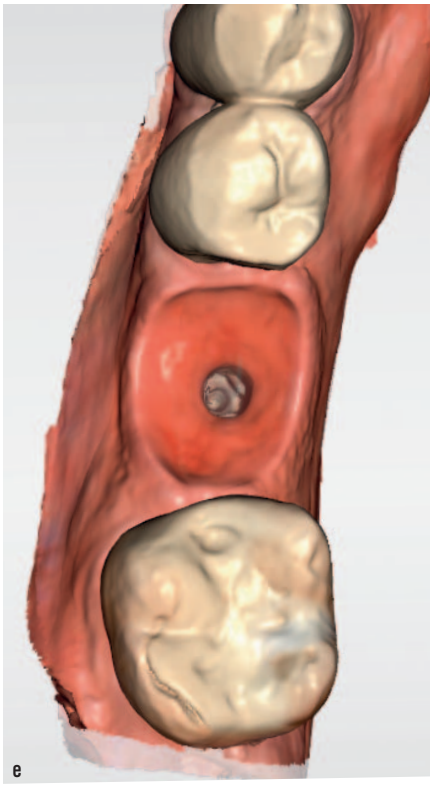


Fig. 10 a to e *(a)* Healed alveolar ridge 3 months after implant placement. *(b)* The anatomic abutment keeps the keratinized tissue apart. *(c)* Emergence profile during impression-taking for the final crown (2 months after second-stage surgery).

Anatomic abutments are compatible with all surgical techniques that augment the soft tissues vertically or horizontally. Their use enhances the final result **(Fig. 11)**.

SEALING THE EXTRACTION SITE WITH ANATOMIC COMPONENTS: THE CERVICAL SOCKET PLUG

In 2020, Valavanis and colleagues described a clinical case in which they sealed an extraction socket with graft material and an anatomic composite resin plug[18].

Even though the approach is experimental, it is worth noting because it illustrates the effect of extraction socket sealing—but not implant placement—on soft tissue management. Remember that the goal is to maintain original soft tissue volume in cases unamenable to immediate postextraction placement. This approach combines the benefits of grafting and sealing the extraction socket with an anatomically shaped component. In a case series currently undergoing analysis, the results clearly demonstrate that the implant plays no part in tissue preservation.

CLINICAL CASE 8 Emergence profile remodeling during second-stage surgery with an apically positioned flap

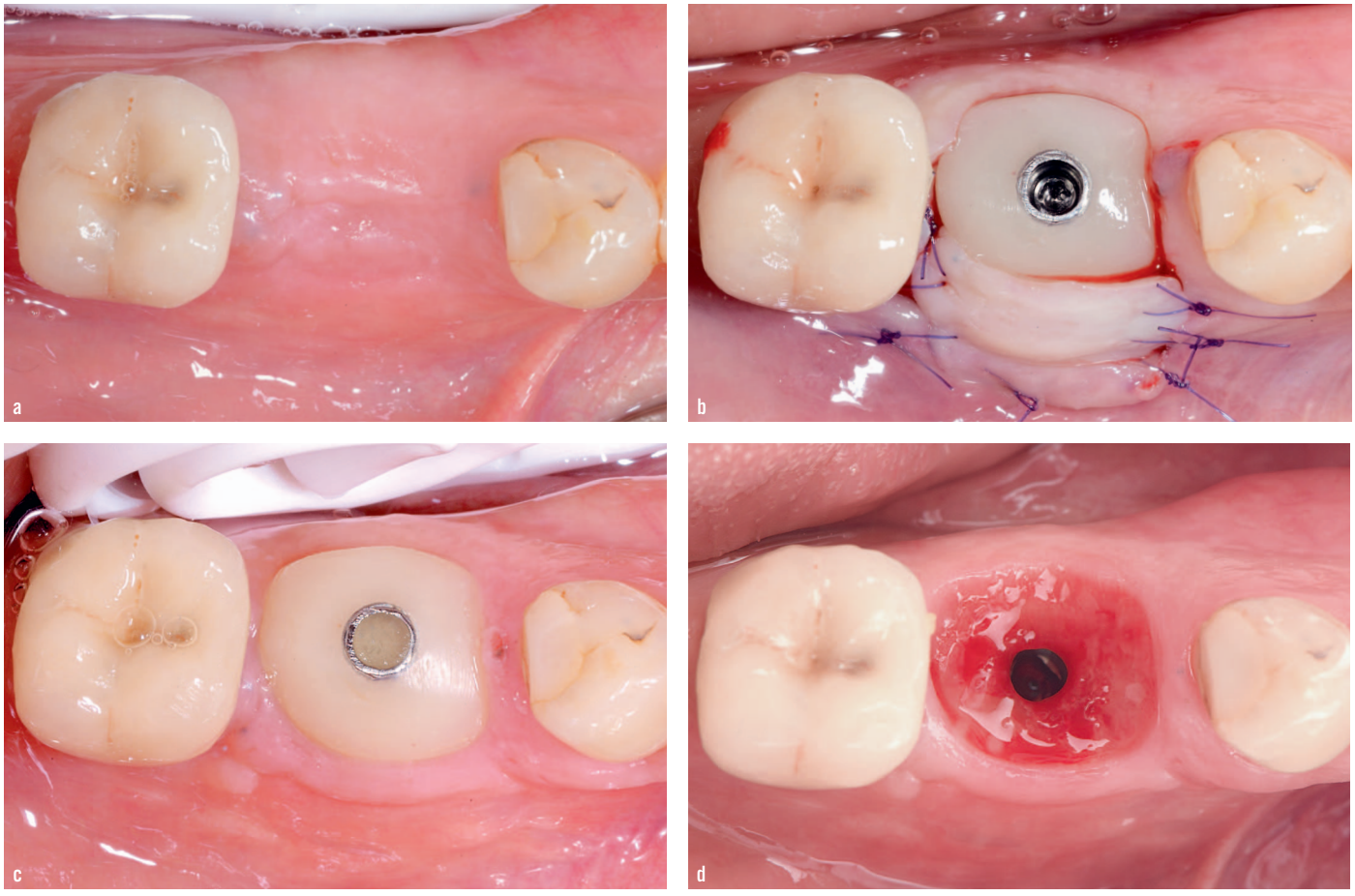


Fig. 11 a to d

Note that the stability of the plug is paramount for this protocol to succeed. The challenge, therefore, is to ensure that the plug stays splinted to the adjacent teeth for 3 to 4 months.

In a comparison of healed tissue volumes against cases of bone grafting *without* socket sealing, there is an undeniable utility to sealing the extraction socket with an anatomic component. Doing so protects the graft material and enhances graft outcome, thereby delaying the need for bone reconstruction. A final advantage of this approach is its minimal invasiveness, since it is entirely flapless **(Fig. 12)**.

CLINICAL CASE 9 Socket preservation with delayed implantation using the cervical socket plug

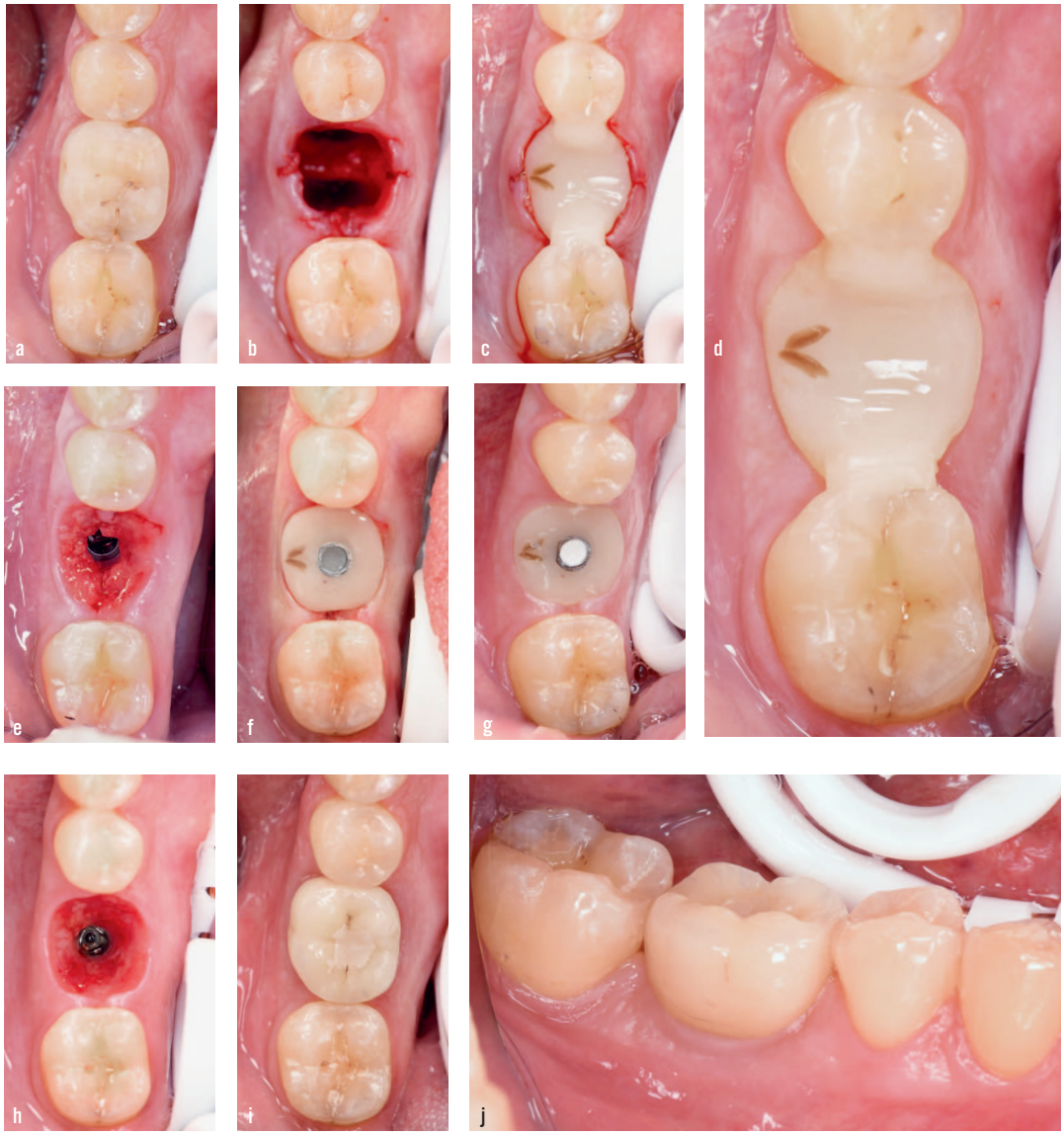


Fig. 12 a to j *(a)* Tissue volume before extraction. *(b)* Atraumatic extraction preserves the socket walls.
(c) Sealing the extraction socket using allogenic graft material (BIObank®) and an anatomic composite resin plug.
(d) Tissue volume preservation 4 months after extraction. *(e)* Guided implant placement using a flapless technique.
(f) Preservation of the emergence profile using an anatomic abutment.
(g) Preservation of tissue volume 3 months after implant placement.
(h) Emergence profile during impression-taking for the final crown.
(i and j) Occlusal and vestibular views on the day of final crown placement

CONCLUSION

Preserving the extraction socket with graft material and/or implant placement is a proven technique for maintaining bone and soft tissue, especially when combined with the use of anatomic abutments. Soft and hard tissue preservation is always recommended to reduce the need for–or indeed facilitate–reconstruction procedures. Tissue preservation does more than just ensure correct implant positioning: it maintains the entire soft and hard tissue architecture around the implant, helping practitioners deliver implant-borne prosthetic restorations that perfectly match patients' esthetic and functional needs.

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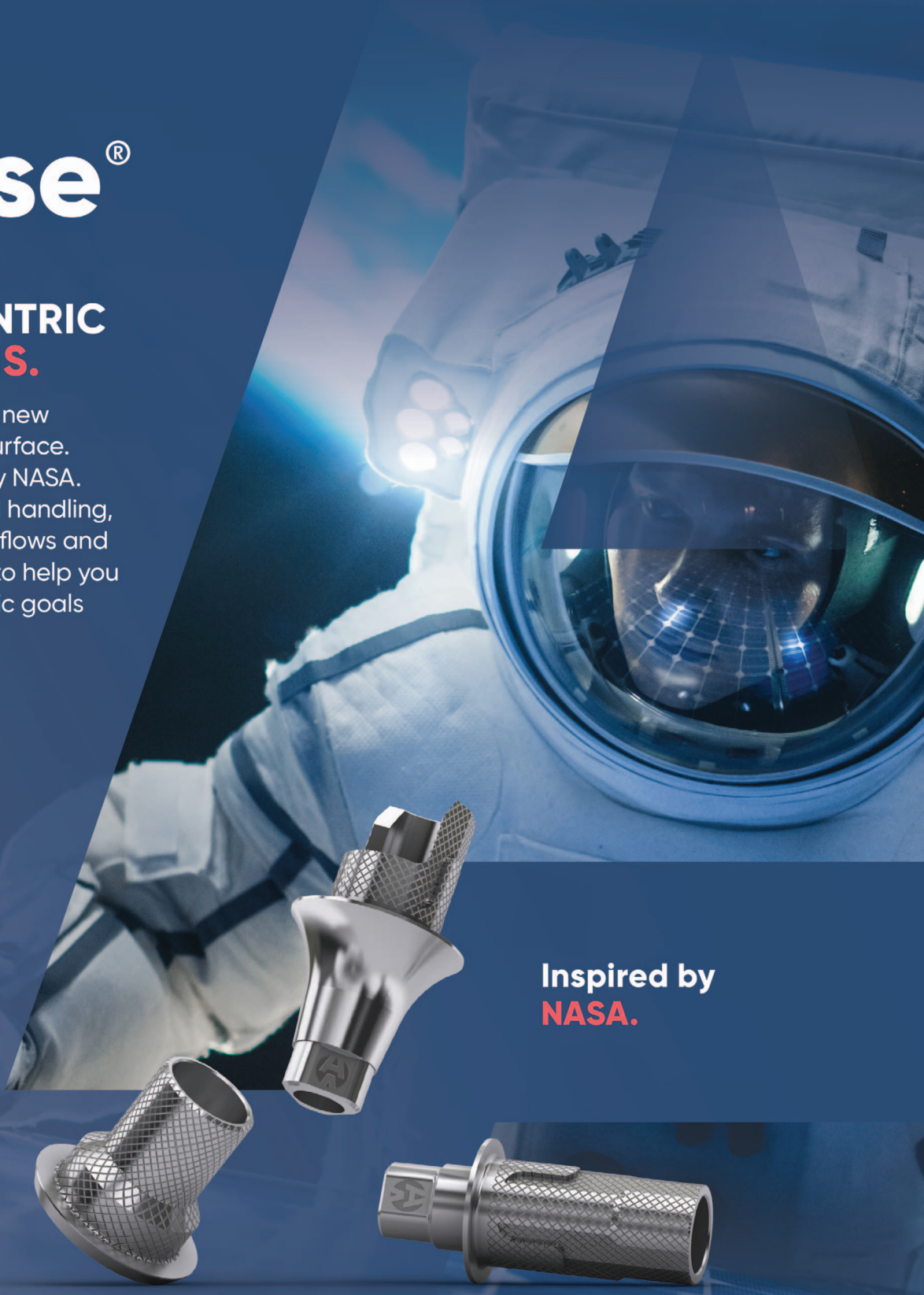

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