Indications for implants in the premolar and molar region

Benefits of the Ø 6mm wide implant

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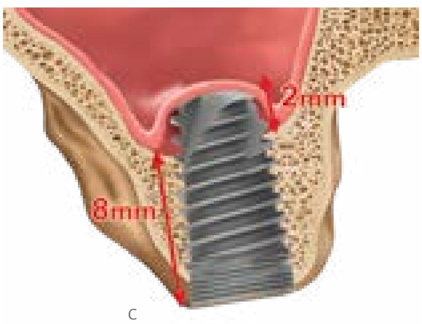
Wide Ø 6 mm implants became clinically available long after standard diameter implants; they have been documented with similar success rates. The aim of this paper is to explore their various indications in the molar region. In addition, the specific surgical attention they require is also addressed.

Introduction

Most dental implants are placed in the posterior area of the oral cavity; they amount to 53.3 % to 65.3 % of the treatments in university settings [1, 2] and 66.5 % in private practice [3]. This region is divided into a premolar and molar area; molars cover 43 – 47 % of the rehabilitations of the region [1, 2]. Among them, the first molars account for 90 % of implant treatment [2]. The 16 – 39 age group experiences the mandibular first molar to be extracted first; the maxillary molar is second [1]. Most frequently, extractions are caused by the failure of an endodontic treatment or follow the fracture of the crown of an endodontically treated tooth that can no longer be prosthetically rehabilitated [4].

Molar extraction is usually not associated with aesthetic issues. Therefore, rehabilitation of these edentulous sites are, unfortunately, not considered with the same urgency as teeth in the anterior region, which are part of the smile aesthetics. Over time, the alveolar crest undergoes a natural resorption process and the available residual bone height (RBH) shrinks until either only implants shorter than 8 mm in length can be accommodated or implant therapy in the upper maxilla requires elevating the sinus membrane and grafting the created space. Patients under 50 are more aware of the loss of the masticatory efficiency. Often, they wish to immediately rehabilitate the newly edentulous site [1, 3]. The large variety of implants which are currently available for implant therapy have been designed to meet the specific needs of every treated site. The dental implants that used to be available during the early 1980s have undergone numerous transforming modifications, which are related to the surface properties, the shape of the implant body, the design of the implant collar, the implant length, the implant diameter and also the geometry of the connection with the abutment. Wide implants of over Ø 4.7 mm were developed by the manufacturers in order to meet the specific demands of the posterior region in terms of biomechanical resistance and better management of the emergence profile of the prosthetic crowns [5, 6, 7]. Implants are considered wide when the diameter lies between 5 to 6 mm; they are labelled ultra-wide when the diameter varies between 7 to 9 mm [8].

The aim of this article is to present the different indications of wide Ø 6 mm implants (Figs. 1a to c) and discuss their surgical uniqueness.



1 I Ø 6 mm Implant. a) 6 mm long implant with a round apex. b) Dimensions of the implant. c) 8 mm long implant; the round apex has been designed to avoid damaging the sinus membrane, while penetrating 1 to 2 mm into the maxillary sinus.

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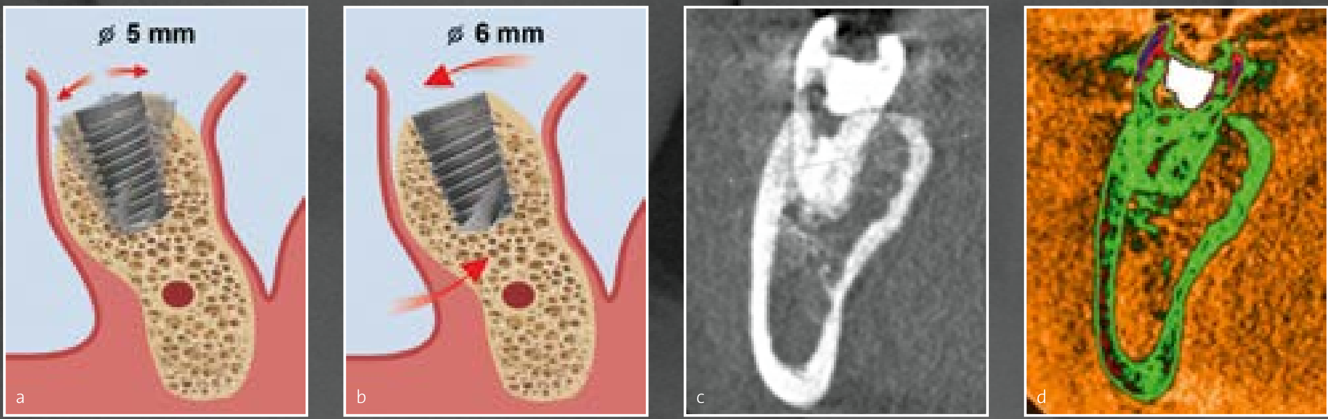
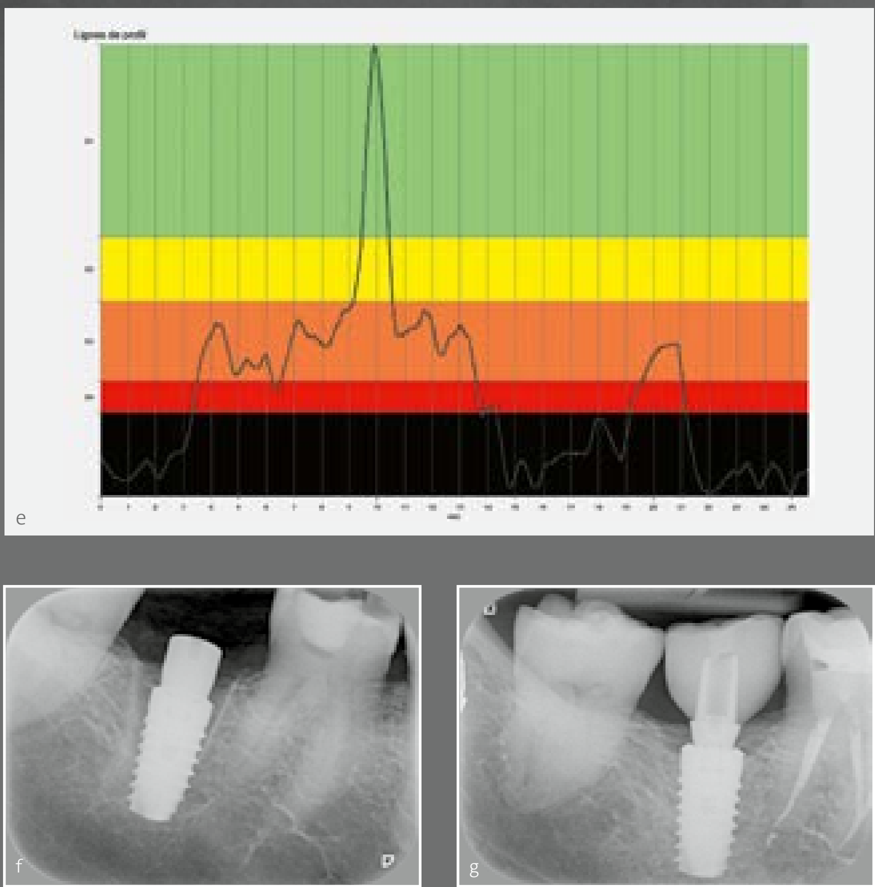




2 I Placement of a Ø 6 mm implant in a site of poor bone density.

a) Illustration showing placement of a Ø 5mm implant with insufficient primary stability.
b) Replacement with a wider Ø 6mm implant providing the desired primary stability.
c) Sagittal section taken at the mandibular second molar showing pronounced internal resorption. The blue line indicates the density profile exposed in the next figure.
d) Sagittal section with various artificial colours representing the different mineral densities. The tooth and the cortical lamellae are in green. In white is the high-density amalgam and in orange is the very poor bone density that covers the whole peri-radicular area and reveals a D5 type density according to Misch classification.
e) Profile of the bone density along the blue line. Apart from the tooth, the amalgam and the bone cortices, the rest of the bone tissue is in black and its density is similar to the noise of the background.
f) Radiograph of the Ø 6 × 11.5mm implant inserted in the post-extraction socket of the second molar.
g) One-year control radiograph. Note the wide diameter implant, the platform-switching feature of the prosthetic abutment and the preserved proximal bone levels.

Indications of wide, Ø 6 mm implants

Implant placement in a site with low bone density

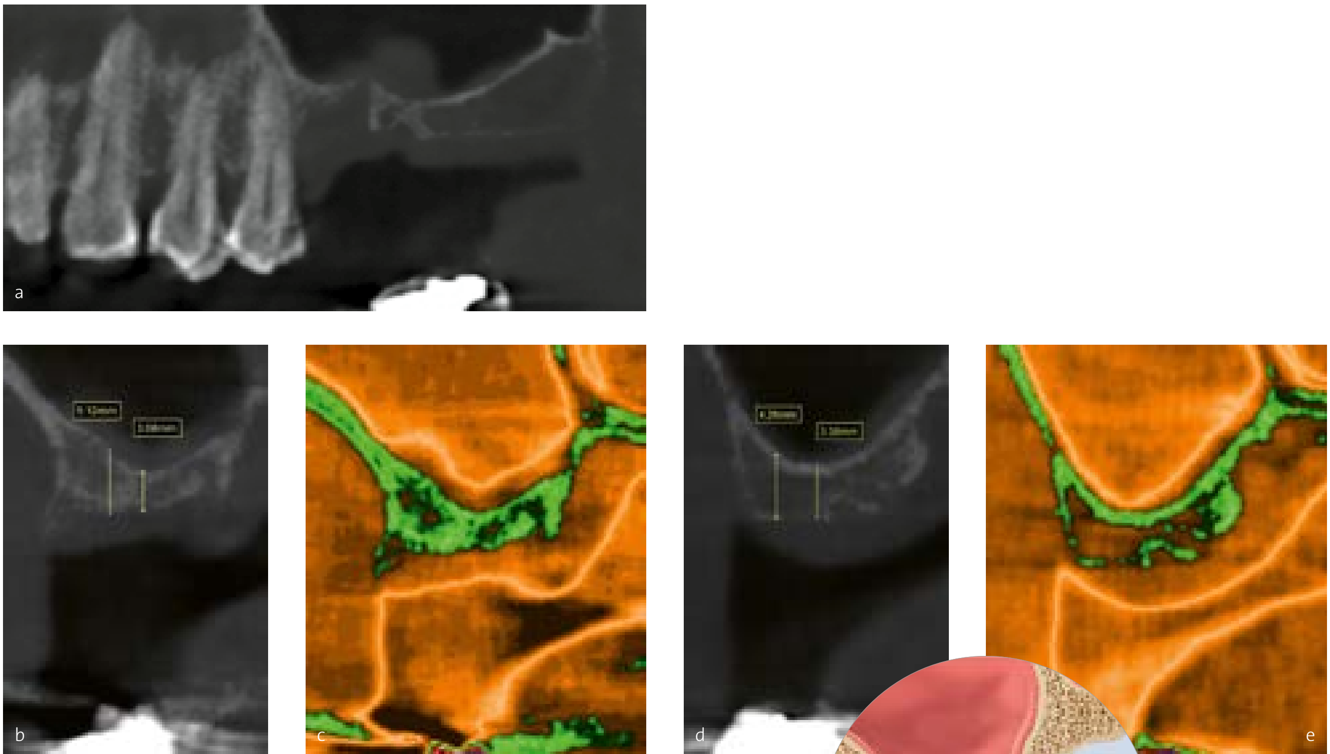
The wide, Ø 6 mm implant may be used an a fortiori rescue implant, in the same way Ø 5 mm implants have been historically used to salvage Ø 4.0 – 4.5 mm implants [4]. This would be the case of a Ø 5 mm implant that has been placed in a healed site or a post-extraction socket in the posterior area and did not achieve primary stability because of a suboptimal drilling sequence or a poor assessment of the local bone quality (Fig. 2a). The surgeon then has the option to go for the next implant diameter, a Ø 6 mm implant, and achieve suitable primary stability (Fig. 2b).

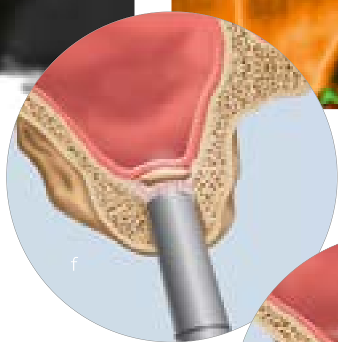
The a priori indication happens when the preoperative computerized tomography (CT) examination taken to treat a to-be-extracted molar site, reveals a poor bone density environment. Better than with a Ø 5 mm implant, one should expect the Ø 6 mm implant to receive stronger bone support from the adjacent cortical lamellae and reach sufficient primary stability. An example of this indication is provided by the 44-year old patient presented in figure 2. The sagittal sections of the CT exam show that the second right molar in the mandible is experiencing considerable internal resorption. Extraction is required (Fig. 2c). Analysis of the tomographic sections reveals very poor bone density precisely at the level of the planned implant site; depiction of the bone quality with various artificial colours denotes the distinct bone densities (Figs. 2c to e). Revealed are the to-be-extracted tooth, the vestibular and lingual cortical lamellae and the poor mineralized bone volume in between (Figs. 2d to e). The Ø 6 × 11.5 mm implant that has been inserted is sufficiently wide to grasp support from the adjacent cortical bone (Fig. 2f); a 25 Ncm insertion torque has been obtained despite the poor bone quality of the implant bed. The radiographic control taken after one year shows the implant, the large platform-switching feature obtained by the prosthetic abutment that is much narrower than the implant collar and the preserved bone levels on the mesial and distal sides of the implant (Fig. 2g).

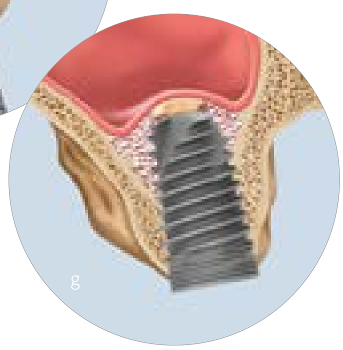
Treatment of a molar site in the maxilla of limited residual bone height and poor density, grafted with a substitute bone biomaterial

When a site to rehabilitate displays a limited RBH and/or poor density, wide implants larger than Ø 5 mm lead to an increase in the implant surface that comes in contact with the surrounding bone, as well as an increase in the insertion torque.

The case presented in figure 3 illustrates this type of indication. This is the story in which a patient presented to restore the left maxillary molar region after having remained edentulous for several years (Fig. 3a). The CT examination reveals a poor density RBH of 3 – 5 mm below the sinus (Fig. 3b to e). The appropriate treatment protocol of these sites within this RBH range encompasses a crestal sinus augmentation procedure with simultaneous implantation. The crestal approach and elevation of the membrane of the sinus floor are illustrated in figures 3f, 3g. These 3 – 5 mm of bone heights are sufficient to accommodate a Ø 6mm implant with an appropriate insertion torque. Two 8 and 10 mm long Seven (MIS, Israel) im-

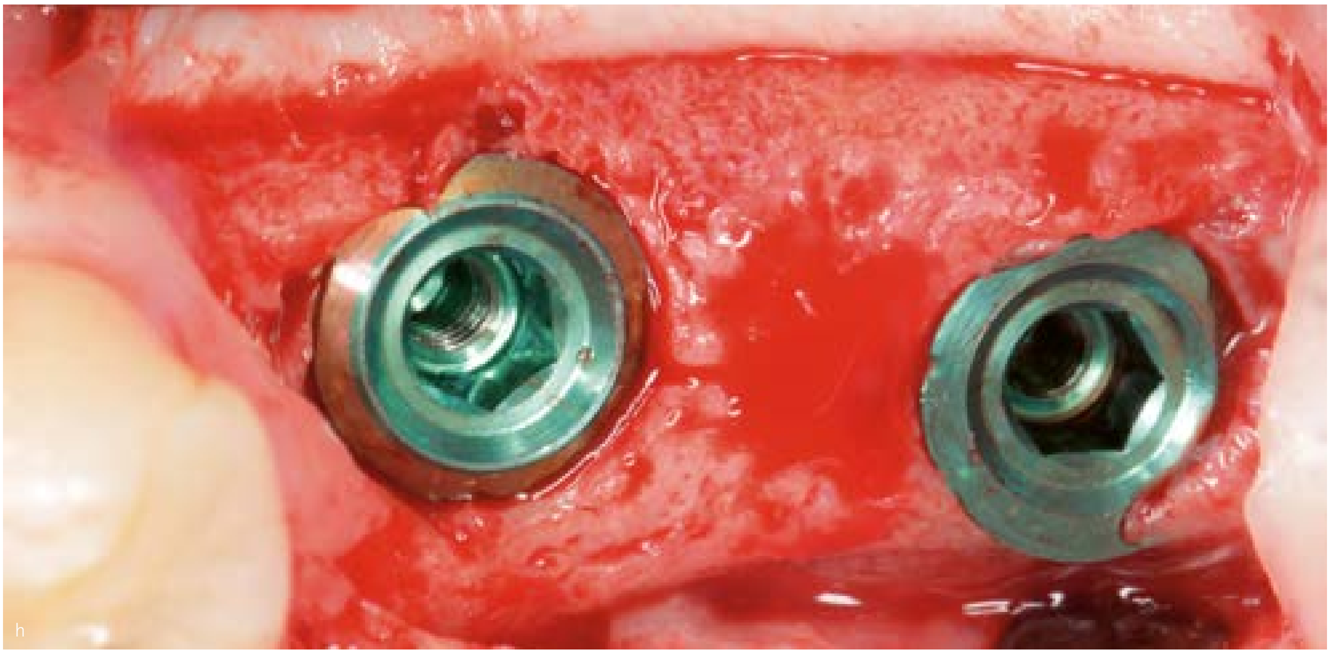




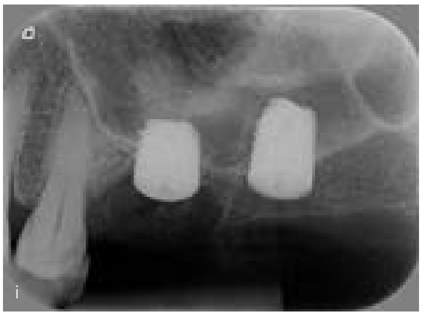


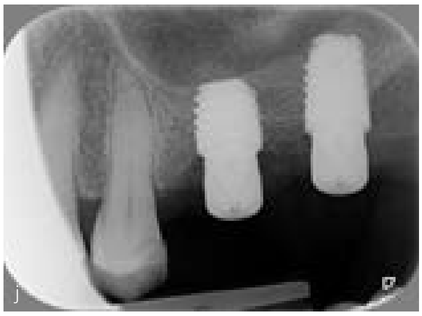
3 I Restoration of a posterior maxillary region using two Ø 6 mm implants.

a) Panoramic view of the posterior region belonging to the CT examination and showing a limited RBH of very poor density.
b) Sagittal section at the level of tooth #26 with the corresponding RBH measurements.
c) Same sagittal section but with artificially coloured densities that highlight the bone density and the thickness of the sinus membrane.
d) Sagittal section at the level of tooth #27 with the resultant RBH measurements.
e) Same sagittal section with the identical artificial colours as used for site #26. Note the poorer bone density as well as the thinner sinus membrane.
f) Illustration of the crestal approach of the sinus floor that involves an osteotome and bone grafting material.
g) Illustration of the grafted site at the end of the procedure. The implant elevated the sinus floor that has been pushed in the space created by the osteotome. Both the sinus floor and the bone substitute material are pushed into the sinus cavity by the osteotome.



h) Occlusal view of the wide, Ø 6 mm implants exposing their corresponding green color coding.
i) Periapical control radiograph following the grafting procedure and implant placement.
j) Periapical control radiograph taken after 7 months of bone healing and after having affixed the multi-unit abutments with a 30 Ncm torque.



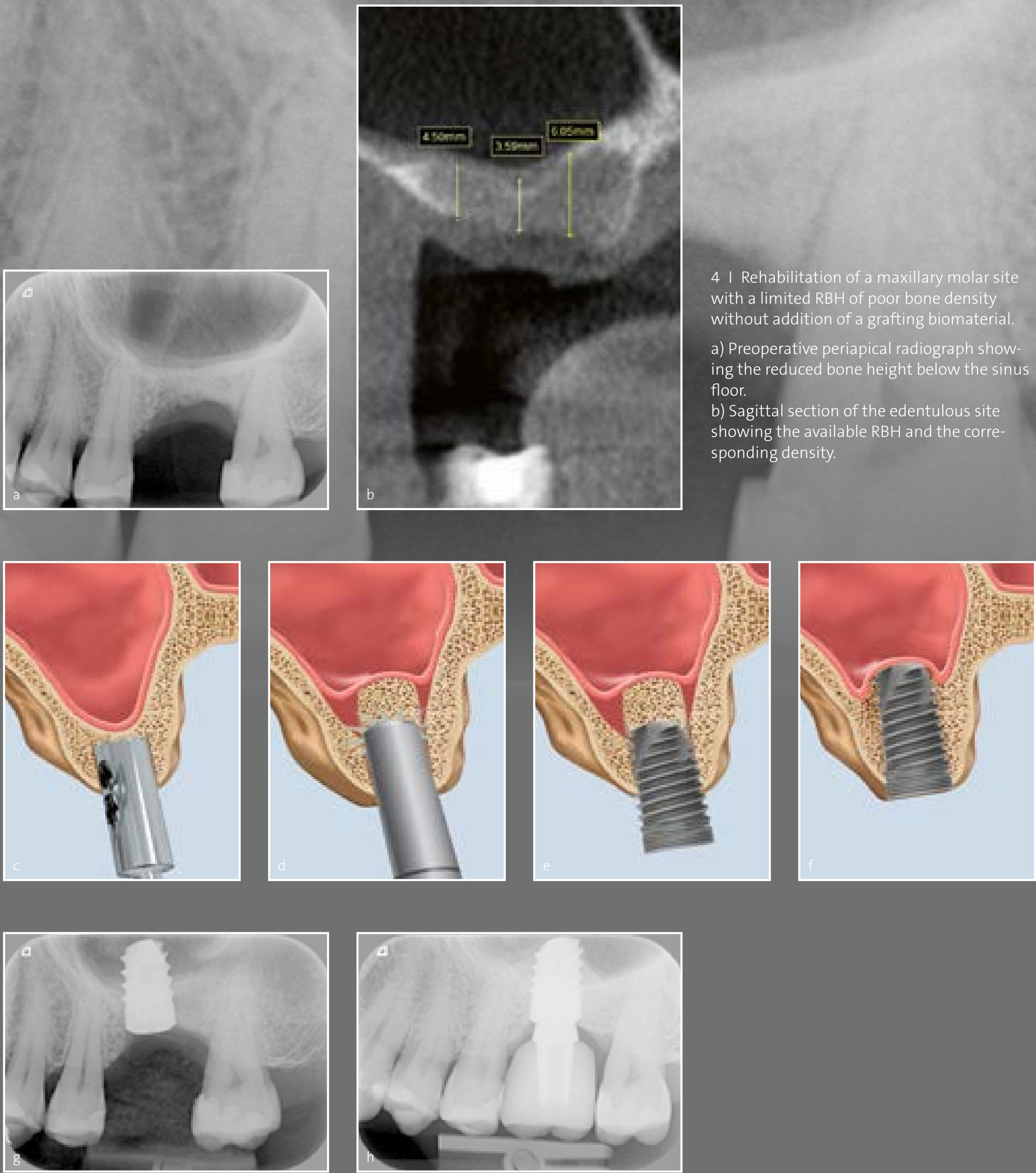


plants are placed with good primary stability. The cover screws are secured in the implant necks and the gingiva is sutured over the implants; Healing is allotted in a submerged fashion for at least 6 months (Figs. 3h to i). After 7 months of bone healing and maturation, the osseointegrated implants are uncovered. The periapical radiographs taken at the end of the second surgical stage show the implants, the multi-unit abutment and the fixed prosthesis (Fig. 3j).

Treatment of a maxillary molar site with limited RBH and poor bone density without grafting procedure

The partially edentulous case presented in this section is similar to the previous one as the RBH is limited and of poor bone density. The aim of the present implantation procedure is to bring the highest percentage of the rough implant surface in contact with bone and achieve the highest primary stability.

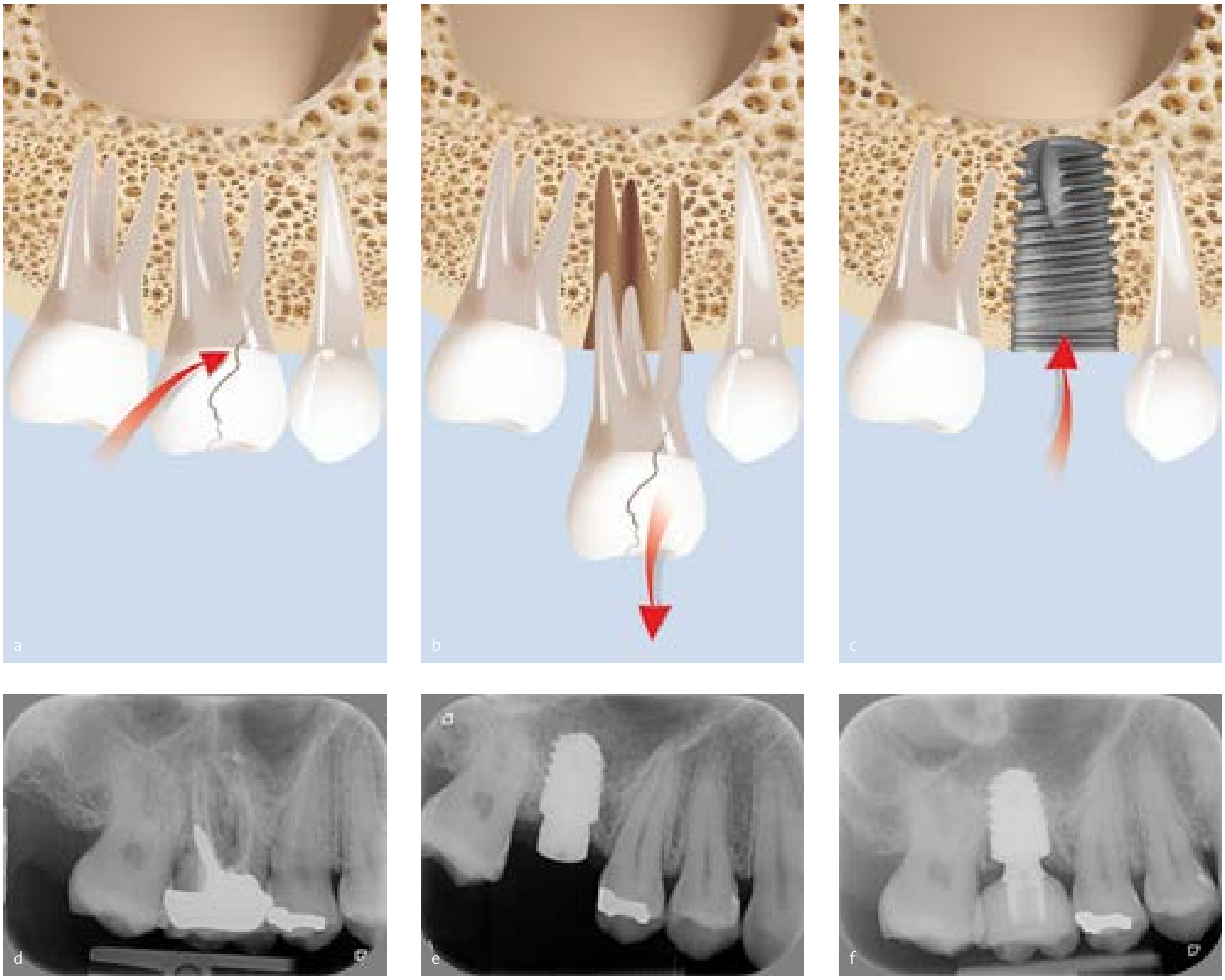
The current clinical situation deals with the restoration of a left maxillary molar where the RBH below the sinus varies between 3.6 and 4.5 mm (Figs. 4a to b). With these bone heights, the crestal approach according to Fugazzotto, with simultaneous immediate implantation may be implemented [9]. The technique involves a trephine of Ø 4.0/Ø 5.0 internal/external diameter; drilling is performed up to approximately one millimetre from the sinus floor. (Fig. 4c). The bone core that is obtained with the trephine is liberated from the sinus floor by a push exerted with a Ø 5.0 mm osteotome. The metallic tool fractures the sinus floor and drives the bone core into the sinus cavity (Fig. 4d). The Ø 6 mm implant is then inserted until final seating in the created implant bed. This brings the bone core deep inside the sinus and detaches further inside the Schneiderian membrane lining the floor of the maxillary sinus (Fig. 4e). By the end of a 6-month osseointegration period, the apical part of the implant which penetrated the sinus is eventually encased in the newly formed bone (Fig. 4f). In the present case, the Fugazzotto technique allowed placement of a Ø 6 × 8 mm Seven implant (Fig. 4g). After the 6-month osseointegration period, a flap is raised, a healing abutment is screwed in the implant neck and the gingiva is sutured around the healing abutment. After soft tissue maturation, a screw-retained single crown with its titanium prosthetic abutment is delivered. The periapical control radiograph taken at the 2-year follow-up shows the Ø 6 mm implant with the newly formed bone at the implant apex that took place without addition of a bone substitute biomaterial (Fig. 4h).



4 I Rehabilitation of a maxillary molar site with a limited RBH of poor bone density without addition of a grafting biomaterial.

a) Preoperative periapical radiograph showing the reduced bone height below the sinus floor.
b) Sagittal section of the edentulous site showing the available RBH and the corresponding density.

c) Illustration of the crestal approach of the Fugazzotto sinus graft technique with the trephine drilling up to 1 mm below the sinus floor.
d) Release of the bone core inside the sinus through the use of a Ø 5 mm osteotome.
e) As the implant is inserted into the implant bed the bone core is driven deeper in the sinus cavity
f) New formation of bone by the end of the osseointegration period around the apex of the implant. The new bone volume completely accommodates the 8 mm long implant.
g) Postoperative periapical radiograph showing a Ø 6 × 8 mm SEVEN implant inserted according to the Fugazzotto technique. The implant apex largely protrudes into the pristine sinus cavity.
h) Control periapical radiograph taken at the 2-year follow-up. Note the screw-retained crown, the platform switching, the preserved bone levels and the bone covering the apex of the implant.

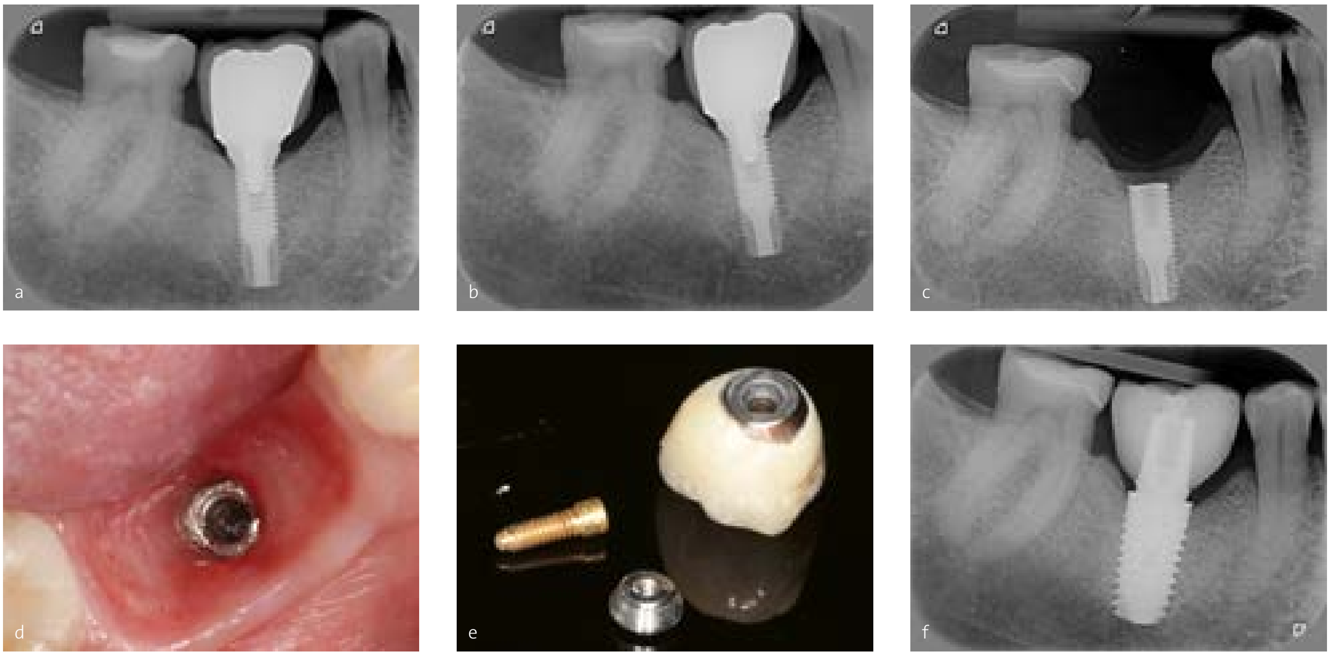


5 I Insertion of a wider diameter implant when a sufficient primary stability cannot be obtained with certainty.

a) Illustration showing a subgingival fracture of a maxillary molar crown.
b) Extraction of the molar.
c) Placement of a Ø 6 mm implant in the extraction socket to rehabilitate the edentulous site.
d) Preoperative peri-apical radiograph of the right maxillary first molar to be extracted.
e) Control periapical radiograph following placement of a Ø 6 × 10 mm implant. The 30 Ncm insertion torque was compatible with a one-stage surgical protocol.
f) Control periapical radiograph taken at the one-year follow-up. Note the preservation of the crestal bone levels, the prosthetic abutment and the wide platform-switching introduced between the abutment and the implant neck.

Replacement of a Ø 5 mm implant with a Ø 6 mm when primary stability is not attained in the maxilla

One of the most relevant indications of the Ø 6 mm implant is to immediately rehabilitate a to-be-edentulous molar site (Figs. 5a to c). From a biomechanical point of view, a Ø 5mm implant is largely able to withstand the mechanical stresses exerted in this posterior area of the oral cavity. Sometimes, a sufficient primary stability is lacking in the post-extraction socket because of the weak dimensions of the inter-radicular septum. Moving to the next implant diameter may solve this issue. Figures 5d to f illustrate the case of a patient that attended the dental office while complaining from an acute pain at the level of the right maxillary first molar (Fig. 5d). A subgingival fracture of the crown of the molar was discovered and extraction of the tooth was required. An atraumatic extraction was performed and the roots left behind a wide socket. Placement of a Ø 5 mm implant did not allow primary stability, so a wider, Ø 6 mm × 11.5 mm Seven implant was chosen to better fill the fresh socket. (Fig. 5e). The periapical control radiograph taken at the first annual follow-up shows the implant-supported crown (Fig. 5f), the large platform-switching feature that allows a better preservation of the initial bone levels and the osseointegrated wide, Ø 6 mm implant.



6 I Fracture of a standard diameter implant placed in the site of a mandibular molar.

a) The periapical radiograph taken during crown delivery shows a standard diameter implant with its widened collar rehabilitating a first molar site.
b) Control periapical radiograph of the implant at the 11-year follow-up. Moderate bone loss is noted on the distal side of the implant down to between the first and second thread.
c) Periapical radiograph of the implant that fractured during year 14. The fracture materialized below the implant collar at the level of the first thread. The proximal bone levels reached the second threads.
d) Occlusal view of the fractured implant. Note the healthy soft tissue.
e) Fractured components. Note the implant collar that endured the fatigue fracture, the crown and the retaining screw.
f) Periapical radiograph of the Ø 6 mm wide implant placed after removal of the fractured standard implant with its crown. Note the more appropriate emergence profile of the crown and the large platform-switching feature.

Replacement of a fractured standard implant restoring a molar site

When the dental implantology community started to endorse restoring teeth in the molar area, only standard Ø 3.75 and Ø 4 mm implants were available on the market (Fig. 6a). Fracture of these standard implants may take place fairly soon after installation, but it can also occur after several years of function. Figure 6a shows the case of a first mandibular molar restored with a standard Ø 4 mm implant with a Ø 5 mm wide collar design. This shape was specifically used to restore the posterior region with a more suitable emergence profile. This implant functioned many years without displaying the typical steep bone loss caused by occlusal overload or showing any other significant bone damage (Fig. 6b). During the year 14 of function, the implant lost its crown. The periapical radiograph revealed that the implant neck fractured below the first thread level due to fatigue (Figs. 6c to e); implant removal could not be avoided. The standard implant was removed with a Ø 5 mm trephine and a Ø 6 × 11.5 mm Seven implant was placed. Restoration of the molar better met both the biomechanical and prosthetic requirements (Fig. 6f). The wide platform-switching feature introduced here by the use of a prosthetic abutment that fits Ø 5 mm implants facilitates superior preservation of the peri-implant bone levels.

Discussion

Wide diameter implants were made available to the market by the end of the 90s as rescue implants, to be used a fortiori in two indications. The first was when the primary stability of a standard diameter implant could not be obtained. The second was to replace an implant explanted next to a fatigue fracture [5]. At the beginning of the clinical use of wide implants, some practitioners reported significantly higher failure rates for the wide diameter implants compared to the standard ones, of up to 20 % [10]. However, more recent meta-analyses of the wide diameter implants have shown that the increased failure rates were specifically involving machined surface implants that were used as rescue implants [7, 8]. When wide implants with a rough surface were used in a priori indications rather than in a posteriori ones, the failure rates of the wider implants were found identical to the standard ones. Reviews of the literature focusing on these diameter implants documented an average crestal bone loss of 0.57 mm measured at the one-year control and a cumulative survival rate of 97 % at five years

[7, 8]. What is noteworthy, is that not all implants wider than Ø 5 mm should be placed in the same category because only wide Ø 5 to Ø 6 mm implants were clinically investigated and taken into consideration. Ultra-wide Ø 7 – 9 mm implants seem to be prone to higher failure rates, 3.7 % compared to 1.45 % for wide implants of lesser diameters [8].

Before the widespread use of the wide diameter implants, healed molar sites were rehabilitated with a standard diameter implant placed in the middle of the edentulous space [5, 6]. This solution was not optimal because:

1) it was subject to biomechanical fractures arising after an unforeseeable period of time (Fig. 6),
2) the prosthetic management of the emergence profile of an 8 – 11 mm wide prosthetic crown, relying on a standard Ø 4 mm implant was an impossible task for the lab technician [11]; in addition it complicated the routine hygiene maintenance of the patient. In those days, another solution was proposed and included two standard or narrow diameter implants tilted one toward the other to support the bulky molar crown [5, 6]. However, this configuration also was coming at the cost of an increased difficulty for the patient to maintain a sufficient standard of hygiene.

Similarly, when post-extraction sites were treated within the frame of an immediate implantation protocol, one of the molar roots had to be selected to receive the standard diameter implant. The position and the direction of this implant were unable to meet the prosthetic requirements of this kind of placement.

Wide, Ø 6 mm implants have the advantage of offering a larger contact surface with the surrounding bone, whether when placed in a fresh extraction socket or in a healed site. This is the reason why some implant systems include 5 to 6 mm long implants only when the diameter is wide. These dimensions are more specifically indicated in molar sites of low residual bone height and/or poor bone density. Alongside their increased mechanical resistance, they allow for a better management of the emergence profile. The wide Ø 5 mm and Ø 6 mm implants share the same diameter for the prosthetic abutment supporting the crown. The platform-switching that results is larger for the Ø 6 mm compared to the Ø 5 mm, meaning it is better shaped to avoid peri-implant crestal loss.

All these consideration do not mean that placing a wide Ø 6 mm implant in a mandibular or maxillary extraction socket of a molar is simple and does not require a learning curve to master it. The SAC Classification (Straightforward, Advanced, and Complex) grades this implant placement as C for Complex [8]. A prosthetically driven surgery in these sites means that the most suitable location for implant placement is often in the inter-radicular septum. The size of these septa are limited; some practitioners even require an available, inter-radicular bone septum of 2.5 to 3 mm before accepting to engage in immediate implant surgery [8]. The first drills may slip on the narrow inter-radicular crestal bone and the following ones may change orientation during the subsequent drilling. The shape of the implant bed may switch from round to oval and fail to provide a sufficient primary stability. To overcome this impediment, some authors proposed to use piezo surgery tips [12], to finish preparing the bony implant bed with osteotomes, to drill through the crown still in place before extraction [13] or to use specific drills conceived to densify the local bone [7]. Despite all the above aspects pointing toward surgical complexity, the clinical studies that surveyed these wide implants placed in post-extraction sockets, rarely reported more failures during the osseointegration period compared to implant placed in healed sites [7, 8].

It is recommended to fill the peri-implant spaces with a low-resorbable bone substitute material; the aim is to achieve a 2 mm wide vestibular and lingual/palatal cortical plate by the end of the osseointegration period. This thickness should ensure an efficient bone support to the overlying soft tissues in the longer term.

Finally, it is advised to position the implant collar 2 mm below the vestibular plate of the socket in anticipation of the vertical bone loss that will necessarily occur during the early physiological remodelling process.

Conclusion

Wide, Ø 6 mm implants were made available for implant therapy later in time than narrower diameter implants. Their success rates are similar to the standard diameter implants.

They are indicated in the molar area of the mandible and the maxilla when:

- The bone quality is insufficient to stabilise a Ø 5 mm implant and it is necessary to seek support from the vestibular and lingual cortical tables.
- The RBH is limited and a larger implant surface is sought after in order to increase the overall bone-implant contact surface.
- The second mandibular or maxillary molar have fused roots, unlike the first molars that present divergent roots. In such cases, immediate implantation of Ø 5 mm implants often leads to compromised primary stability.
- In the posterior region of the maxilla, their wide and round apex reduces the risk of damaging the Schneiderian membrane of the sinus during a bone grafting procedure with sinus floor elevation via the crestal approach with either the osteotome technique or Fugazzotto's.
- A standard diameter implant is fractured or is removed because of crestal bone loss caused by overload, and an immediate larger implant is indicated.

In fresh extraction sockets, the surgical technique is not straightforward; the surgeon must go through a learning curve to get the skills and get acquainted with the specific tools and methods that will help attaining the desired primary stability in these sites.

The references are available at www.teamwork-media.de/literatur

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