Implant design factors that influence the longevity of osseointegration.

Radiographic evaluations after 10 years of clinical function of the Aadva implant system

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Nowadays, replacing missing teeth by implant-supported restorations is one of the most predictable and safest treatment option a clinician can perform, with success rates of 97% and higher. Highly satisfactory results for patients and professionals are achieved.

One of the challenges of implantology is to maintain stable, healthy and functional results in the long term. There are multiple factors from different areas that can influence this success, related either to diagnosis, surgery, prosthesis or maintenance. This article focuses on the characteristics of the implant design and those of the GC Aadva Implant system in particular, and their impact on the treatment durability. Seven clinical cases treated with this system are presented, including controls up to 10 years after treatment.

While patient's age, anatomy, bone quality, and surgical procedure all affect the survival rate of dento-alveolar implants, the implant design has been proven to be highly impactful as well. Since the late 1970s, when the concept of osseointegration had been introduced in the dental community, there has been an interesting evolution in the macroscopic (body design and thread geometry) as well as microscopic (implant material, surface morphology and coatings) aspects of the design.

THE AADVA IMPLANT DESIGN
Aadva Standard and Tapered Implant. **a.:** coronal micro-threads; **b.:** angled polished neck; **c.:** internal conical prosthetic connection with platform switch; **d.:** microstructure of the surface of high industrial quality (contaminant-free).

The implants' **MACRODESIGN** entails several interesting aspects that affect the long-term survival.

- The progressive double thread gives a self-tapping capacity to the implant that helps optimize bone preparation conservatively, while facilitating the achievement of good primary stability[1].
- Coronal micro-threads increase the contact surface with the bone, as well as a better distribution to the bone of the forces that the implant receives[2]. Micro-threads also increase the stiffness in the neck of the implant, which is a critical area since it involves the prosthetic connection and a lower thickness of the implant.
- The angled polished neck helps to create a stable tissue biological seal, as it leaves more room for soft tissues, and facilitates the attachment of such tissues to the implant[3].
- Platform switching also helps maintaining hard and soft tissues, as it horizontally distances the bone connection, decreasing marginal bone loss[4].
- The internal conical connection with hexagonal block brings multiple advantages to the implant-restoration complex. First, it facilitates an airtight seal that prevents bacterial contamination[5], which helps maintain the biological width. It also simplifies the positioning of prosthetic parts, while having a lower incidence of loosening of prosthetic screws than external connections[6]. The conicity ensures a homogeneous distribution of mechanical forces and stresses[7]. All these factors help to achieve a stable prosthetic connection.

Note that in the macrodesign of an implant, a favourabe distribution of forces is a key factor: this means that compressive forces are maximized while tensile and shear forces are minimized. However, depending on the bone quality, different types of design may be necessary. Excessive compressive forces during implant placement may lead to pressure necrosis and is more likely to occur in very dense bone. Tapered implants induce more compressive forces and are indicated in weaker bone to enhance the primary stability. The Aadva Tapered Implants also have a slightly increased thread depth in comparison to the Aadva Standard Implants, also to increase their primary stability.

The implants' **MICRODESIGN** affects the long-term survival as well and should be given equal importance:

- Titanium has a rather unique potential to osseointegrate: it is fully inert and highly biocompatible.
  There are different degrees in the composition of the titanium of the implants. Titanium grade 5 is the most used titanium alloy in dental implants and has excellent mechanical properties[8,9].
- For decades, attempts have been made to improve the microstructure of the implant surface, trying to increase its roughness in order to increase the bone-to-implant contact and to decrease the unfavourable shear forces. Different types of chemical and/or mechanical treatments have been implemented for this purpose[10]. In case of Aadva Implants, the SLA treatment is used, which consists of sandblasting with large-grit aluminium oxide particles, as well as acid etching. It has been shown to improve, favour and stimulate osseointegration[11]. While

contaminants and accidental chemical modifications are frequently present on the surface of many of the SLA-type implants, Aadva implants show high industrial quality, and the surfaces are free of any type of pollution or contamination[12]. Pollution and contamination of implant surfaces should be avoided, as they entail a risk of causing severe clinical impact, such as peri-implantitis or early implant loss[13].

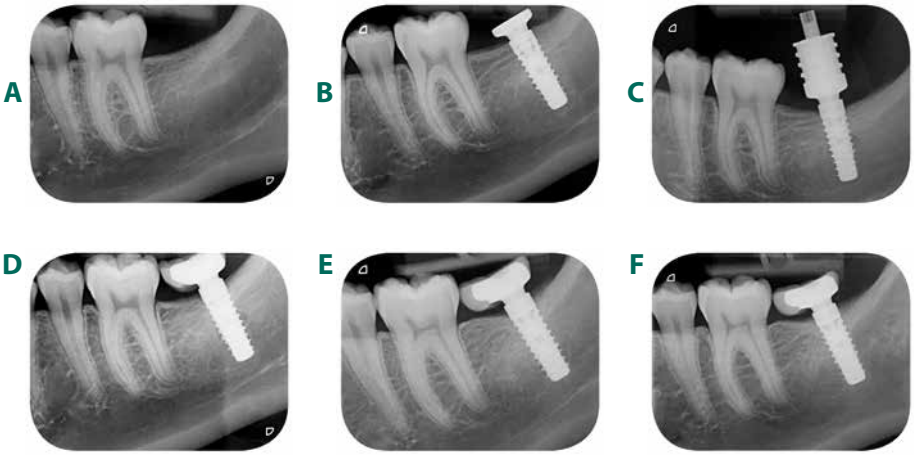
- The variable surface roughness in Aadva implants, with the roughness increasing towards the apical area, favours the adaptation to the cellular response in different areas to accelerate osseointegration.

All these aspects of the macro- and microdesign of the implants facilitate the preservation of bone tissue as well as the overlying soft tissues.

CLINICAL CASES

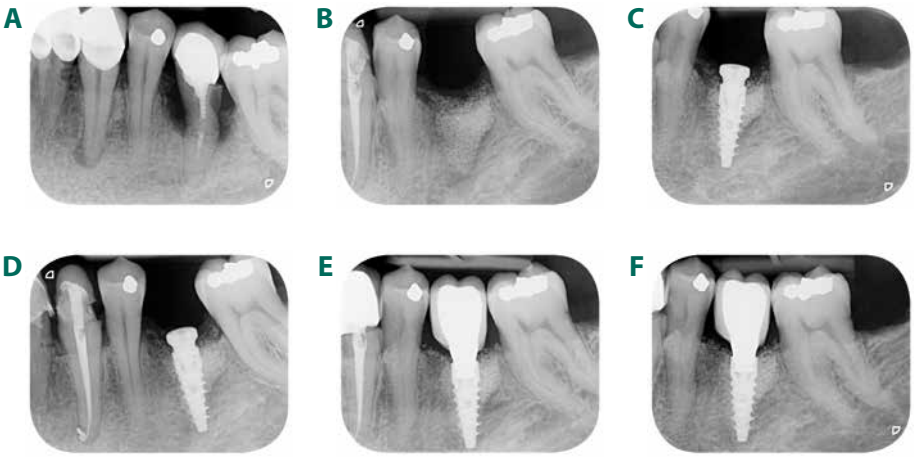
Case 1

A: 20-year-old woman with agenesis of 37. **B:** Implant placement Aadva Standard Regular 12mm. **C:** Taking impressions at 2 months. **D:** Restoration with metal-ceramic crown screwed directly to implant. **E:** Follow-up at 7 years after treatment. **F:** Follow-up at 10 years after treatment.



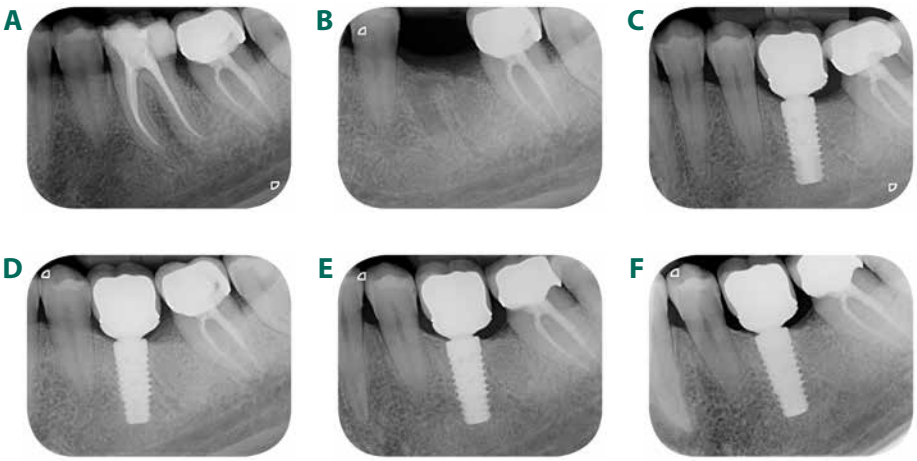
Case 2

A: A 43-year-old man with insufficient root canal sealing in 45, root resorption and circumferential bone loss. **B:** Extraction and guided bone regeneration with xenograft and resorbable membrane. **C:** Aadva Tapered Regular 12mm implant (placement at 6 months post-extraction). **D:** After 2-month osseointegration period. **E:** PFM crown screwed directly to implant. **F:** Control at 7 years after treatment.



Case 3

A: A 40-year-old woman with a vertical fracture of 36. **B:** Bone state at 6 months post-extraction. **C:** Aadva Standard Wide 12mm implant with cemented metal-ceramic crown on CAD-CAM custom abutment. **D:** Control at 2 years. **E:** Control at 6 years. **F:** Control at 10 years.



Case 4

A: A 57-year-old woman with an absence of 47. **B:** Intra-surgical control of distance to the inferior dental nerve. **C:** Aadva Standard Regular 10mm implant. **D:** Taking impressions at 2 months. **E:** Porcelain fused to metal screw-retained crown **F:** Control at 10 years.

A 

B 

C 

D 

E 

F 

Case 5

A: A 43-year-old man with absence of 24 and distal angular intraosseous periodontal defect in 23. **B:** After periodontal treatment and periodontal regeneration of distal defect of 23. **C:** Aadva Tapered Regular 12mm implant. **D:** PFM crown screwed directly to implant in 24. **E:** Control at 7 years of follow-up.

A 

B 

C 

D 

E 

Case 6

A: A 49-year-old woman with an absence of 36. **B:** Aadva Standard Regular 12mm implant. **C:** Taking impressions at 2 months. **D:** Metal-ceramic crown screwed directly to implant. **E:** Control at 10 years.

A 

B 

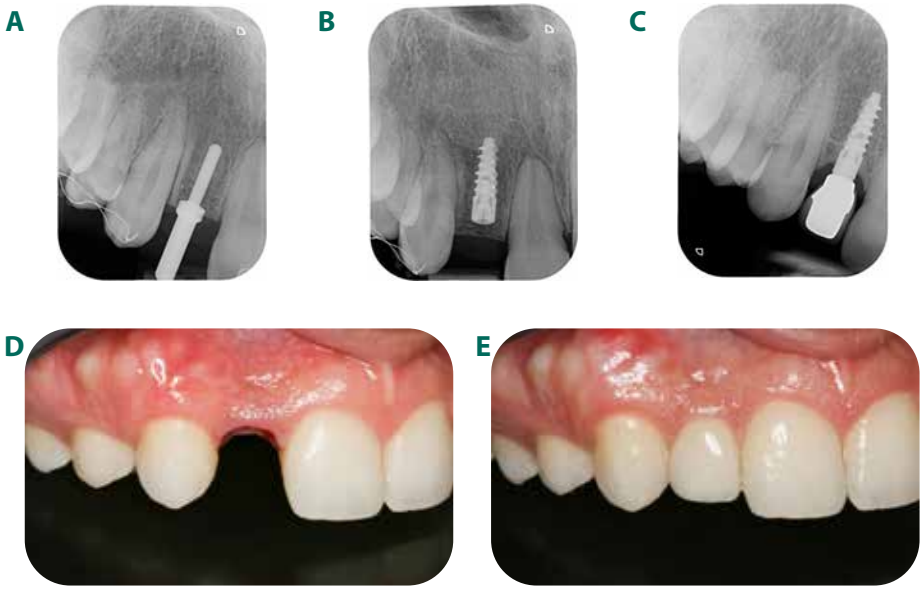
C 

D 

E 

Case 7

A: A 29-year-old man with congenitally missing 12. Intra-surgical control of angulation and distance to adjacent teeth. **B:** Aadva Tapered Narrow 12mm implant. **C:** Control at 5 years. **D:** Emergency profile prior single-unit crown connection. **E:** After 5 years of function, the soft-tissue preservation is still excellent.



Conclusion

Factors related to implant design can influence the interface between bone and implant, and therefore the success. An understanding of the biological and physical principles and correct application thereof could decrease failures observed by the clinician. Even though implant treatments generally already exhibit high success rates, additional improvements could lead to advancements in treatments in less predictable situations such as immediate implant placing and loading, implant placement in smokers and diabetics, and placement in less than ideal bone quality.

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