Skeletal class III malocclusion case

Anchorage optimisation using combined tissue-level and bone-level implants

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Managing skeletal class III malocclusion can be quite complex and typically requires an interdisciplinary approach to develop a comprehensive treatment plan. This condition has a multifactorial aetiology and is often associated with multiple dentoalveolar complications, including anterior and/or posterior crossbite resulting from maxillary retrognathism and mandibular prognathism, along with vertical and/or transverse problems.[1] These complications can increase the patient's susceptibility to dental caries, periodontal disease, edentulism and also have psychosocial ramifications.[2, 3]

When orthognathic surgery is not an option, the restorative prosthetic project for a full-mouth rehabilitation becomes quite complex, often requiring an increase in the vertical dimension of occlusion (VDO).[4] Endosseous implants have proven effective in providing the necessary anchorage for modifying VDO and augmenting the interarch distance.[5–7] In many class III cases, partial or total edentulism is accompanied by jawbone atrophy. In these situations, regenerative approaches like guided bone regeneration and autogenous or xenogeneic connective tissue grafting are simultaneously employed to compensate for the loss of soft- and hard-tissue volume.[8] Additionally, post-extraction implant placement approach may be used, where feasible, to further minimise vertical and horizontal resorption, improving gingival tissue aesthetics.

Bone-level and tissue-level implant systems have comparable clinical outcomes.[9, 10] Nonetheless, tissue-level implants may offer advantages in the management of periodontal disease and the restoration of posterior non-aesthetic areas. A single-stage tissue-level implant system with polished transmucosal collars and concave necks moves the microgap away from marginal bone, promoting optimum bone and soft-tissue health. Furthermore, these features also reduce bacterial buildup and the risk of peri-implantitis, thereby enhancing implant survival rates and preserving stable marginal bone levels.[11, 12] Self-tapping implants have enhanced bone densification capabilities, permitting streamlined surgical techniques with less drilling. This facilitates primary stability which is critical for implant success especially in cases where immediate loading is desired.[13] The implant characteristics and protocols described above were pivotal in achieving the treatment goals of this clinical case, including: increasing VDO, volumetric augmentation, minimising lip protrusion and correcting anterior cross


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Fig. 1: Extra-oral smile showing lower lip profile and slight gingival exposure. – **Fig. 2:** Lateral extra-oral view demonstrating skeletal class III relationship with crossbite and a concave facial profile. – **Fig. 3:** Intra-oral view showing crossbite and occlusal collapse. The occlusal plane is decompensated due to collapse and wear. Multiple root remnants with associated lesions and caries are present.

bite, improving facial profile and rehabilitation of the functional occlusion with prosthetic rehabilitation.

Patient history and diagnosis

A 63-year-old male patient presented for consultation with the primary concern of restoring masticatory function and aesthetics. Clinical examination, supported by extra-oral and intra-oral photographs showed a skeletal class III malocclusion compounded by the loss of vertical dimension. The bite collapse generated an anterior crossbite that improved when the patient's vertical dimension was increased, although the bite planes remained unbalanced. Partial edentulism was observed in the posterior sector (Figs. 1–3) accompanied by multiple pathological findings, including lesions, root debris and loss of vestibular cortex (Fig. 4).

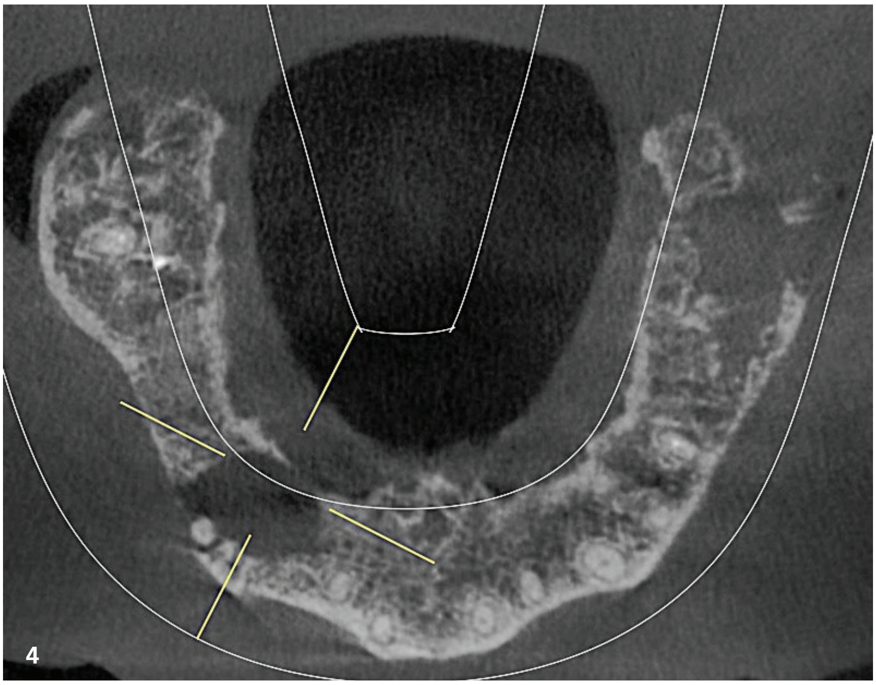


Fig. 4: Diagnostic Radiographs: Radiovisiography (Vistascan, Dürr Dental) and CBCT (Orthophos SL, Dentsply Sirona).

Treatment plan

DICOM and STL files were merged for surgical planning in coDiagnostiX®. Bite registration and a digital diagnostic wax-up (inLab Dentsply Sirona) were created to guide the entire restorative workflow (Fig. 5). The treatment plan included bimaxillary implantation of tissue-level implants with varying gingival heights (Fig. 6), a bone-level implant in position 46 at a later time point, and veneers on the remaining mandibular teeth.

Surgical procedures

Following the extraction of the remaining teeth and residual root fragments in the maxilla, flapless guided implant surgery was performed. A downsized drilling protocol was employed and depth control achieved using drill stop kit in accordance with manufacturer's guidelines. Axiom X3® tissue-level implants were placed along with multi-unit abutments of matching diameters. The Implant Stability Quotient (ISQ, Ostell) ranged between 65–72, indicating high primary stability and supporting the feasibility of early loading (Figs. 7–10).

The lesion at site 34 was grafted, and a slowly resorbable membrane (Straumann® Membrane Plus) was securely placed and fixed in position with pins (Fig. 11). A digital impression of the upper arch was then captured before initiating the healing phase by capping the multi-unit abutments to fully protect the fixtures. The provisional CAD/CAM restoration in PMMA was designed and digitally validated using exocad software, milled (Simeda), and precisely fitted five days post-surgery. The PMMA restoration was firmly affixed to straight titanium bases in the posterior region and to angled ones in the anterior zone for optimal alignment (Figs. 12+13).

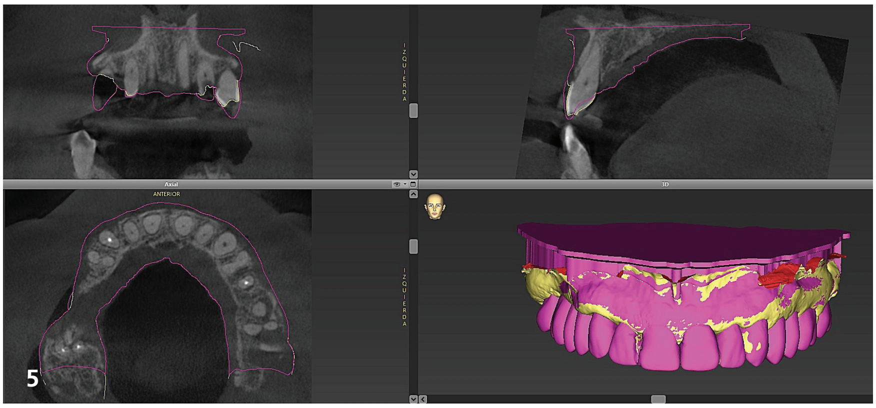


Fig. 5: Superimposition of the initial STL file and the digital design STL. The layers are virtually aligned: the yellow layer represents the initial condition, and the pink layer represents the virtual wax-up.

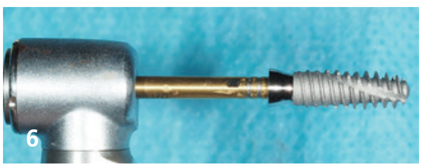
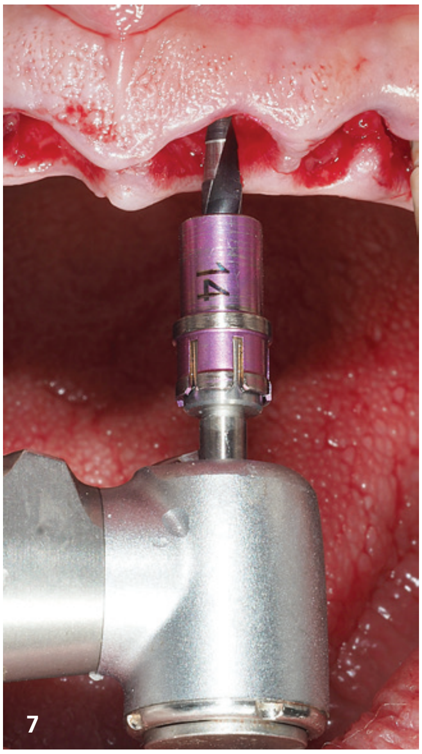


Fig. 6: Axiom X3® tissue-level implant. The implant coils and lateral chamber are visible; the transporter appears gold-coloured.



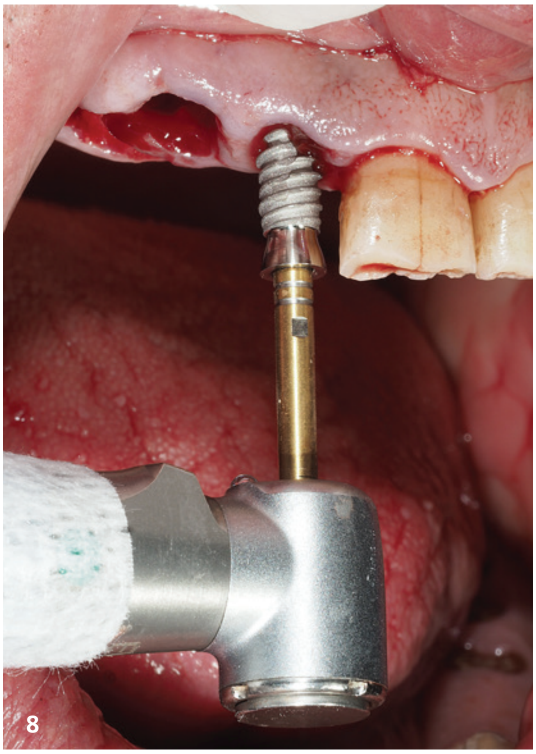
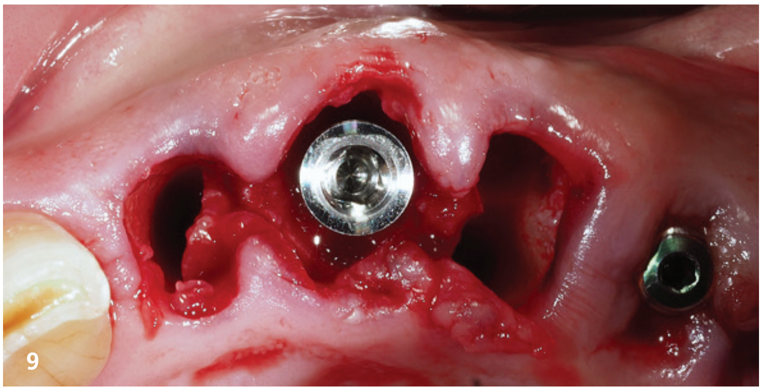
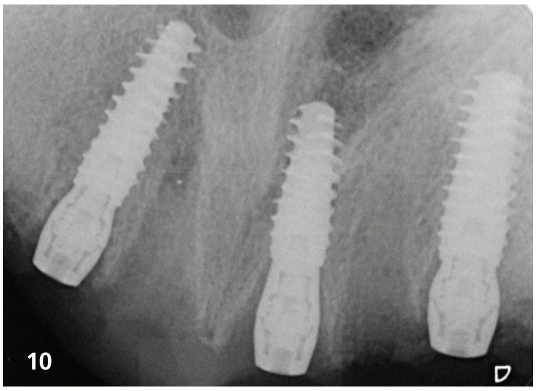
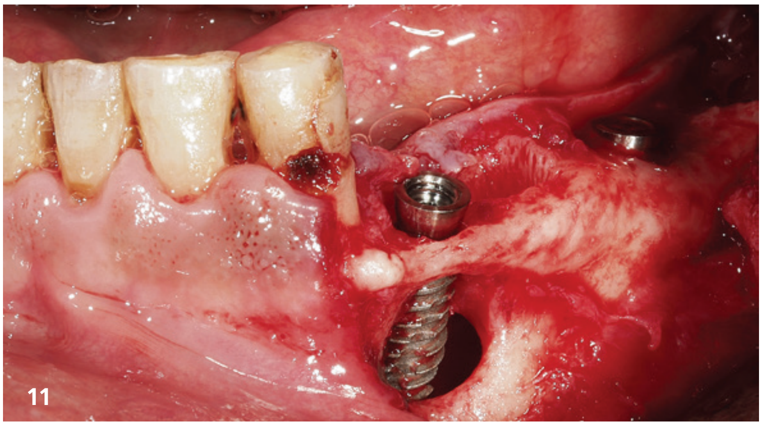


Fig. 7: Alveolar milling performed using colour-coded depth stops and laser markings. – **Fig. 8:** Implant insertion at low rotational speed. The surgical guide enables precise control of the insertion path. – **Fig. 9:** Occlusal view showing the polished collar. A distal multi-unit abutment and healing cap are positioned to prevent initial soft-tissue collapse and facilitate subsequent digital scanning. – **Fig. 10:** Radiograph of anterior–superior implants with multi-unit abutments following the "one abutment, one time" protocol and associated healing caps.







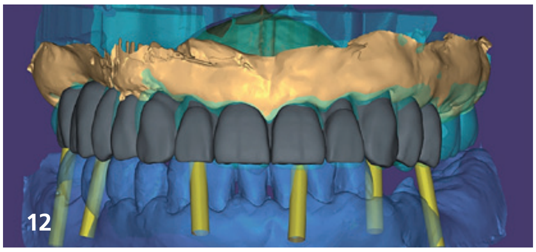


Fig. 11: Axiom X3® tissue-level implant positioned within the bony framework; posterior site prepared for defect regeneration. – **Fig. 12:** Design of the provisional restoration based on the digital wax-up, incorporating angulation correction. – **Fig. 13:** Early loading in place, following digital wax-up parameters for crossbite correction and vertical dimension restoration. Teeth 11–21 were not lengthened to preserve anterior guidance during crossbite correction.

At a later stage, undersized drilling and sub-crestal placement of an Axiom X3® bone-level implant in site 46 was done, achieving an ISQ value of 75. Subsequently, a healing abutment 5.0 x 3.5 mm gingival height was placed to establish an appropriate emergence profile for the prosthetic phase. Six months post-surgery, the PMMA load resulted in a satisfactory soft-tissue response, with well-contoured gingiva suitable for the final prosthetic integration (Fig. 14). The natural teeth were reshaped for full veneer crowns, and the PMMA provisional modified to achieve the desired new vertical dimension and favourable occlusal harmony with the upper temporary restoration. New ISQ confirmed succesful osseointegration of all implants. Optical scans were obtained using multi-unit scanpost in PEEK or titanium. A lower gingival height in 34 necessitated a direct connection on Axiom X3® tissue-level implant for optimal aesthetics (Figs. 15+16).

A passive fit test was then conducted to verify the accuracy of the CAD/CAM framework prior to the generation of a 3D-printed master model. This test involved a milled titanium bar to ensure the precision of the previous scan. Although it is the most expensive method, it is also the most accurate way to generate the final 3D model. Upon design validation in exocad, the fit was confirmed by the Sheffield test. If any stress points were identified, the bar was sectioned and repositioned using low shrinkage resin where possible (Fig. 17).

The ideal free vertical dimension was preserved by utilising temporaries as biocopies to create printed models and design the final restorations. The upper restoration consisted of a hybrid structure; an anodised titanium bar cemented to a (SINA XT-T) zirconia secondary structure, designed to mitigate potential tensions arising from the material's rigidity. The lower restoration utilised a screw-retained system with SINA XT-T zirconia crowns (Figs. 18+19). At site 46, the final restoration consisted of a CAD-CAM anodised titanium abutment featuring retentions and a zirconia crown (Fig. 20).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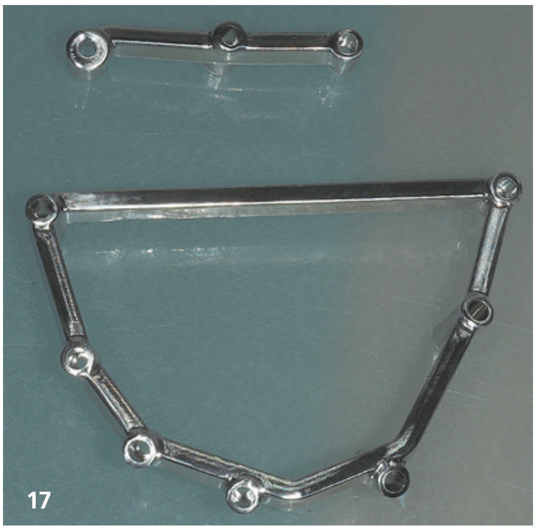
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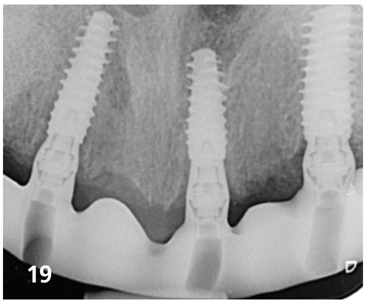
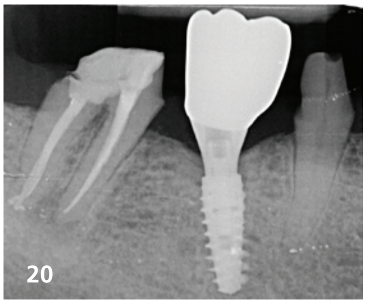
Fig. 14: Soft-tissue condition after osseointegration of the upper implants. – **Fig. 15:** Vestibular view showing upper scanposts and gingival contours shaped by the provisional restoration. – **Fig. 16:** Multi-unit digital transfers in titanium at positions 36–37, and PEEK digital transfers with direct tissue-level connection. In region 46, a titanium BL digital transfer is placed. – **Fig. 17:** Titanium-milled passivity test component prepared for verification.





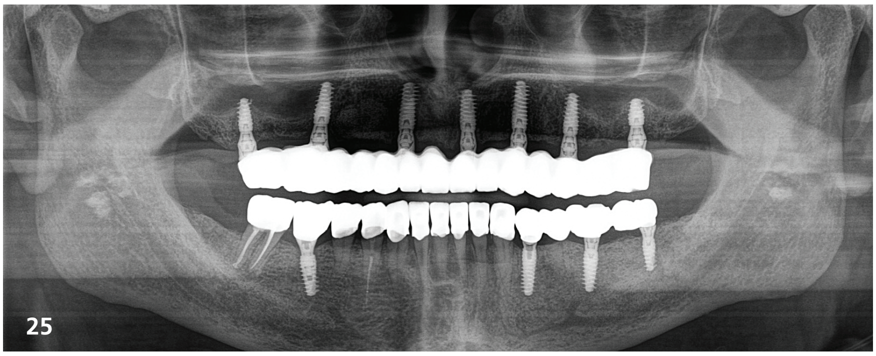


Fig. 18: Anodised, milled titanium primary structure and SINA XT-T zirconia secondary structure with angled screw access and screw-retained cementation. – **Fig. 19:** Radiographic verification of the intra-oral fit of the primary structure. – **Fig. 20:** The milled abutment presents subcrestal and gingival portions, forming the subcritical and critical contours without bone compression. – **Figs. 21–25:** Final outcome of upper and lower restorations showing occlusal rehabilitation and crossbite correction. Radiographic follow-up at six months.

The full veneer crowns were cemented using glass ionomer cement. Crown 46 was extra-orally cemented (3M™ RelyX™ Espe). The final outcomes of the case included restoration of the bite collapse, correction of the crossbite and restitution of the occlusal plane. A final radiographic evaluation was performed at six- and 20-months post-implantation (Figs. 21–25).

Conclusions

Strategic use of both TL and BL implants enabled optimal clinical outcomes. TL implants supported soft tissue stability, particularly in the context of pathology and multi-unit restorations, while BL implants offered enhanced control over emergence profiles and greater prosthetic flexibility in the single-unit site. Underscoring the need of adaptable and comprehensive implant and restoration systems. The outlined treatment strategy offers valuable insights for dental professionals managing analogous instances, highlighting the need of thorough evaluation, meticulous planning, and multiple validation phases of restorations to achieve aesthetically pleasing results. Moreover, the incorporation of a digital workflow in the treatment plan including digital imaging, virtual treatment planning, guided implant placement, and CAD/CAM prosthetic fabrication, enhances precision, efficiency, and predictability throughout the treatment process, reinforcing the value of technology-driven interdisciplinary care.

References

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