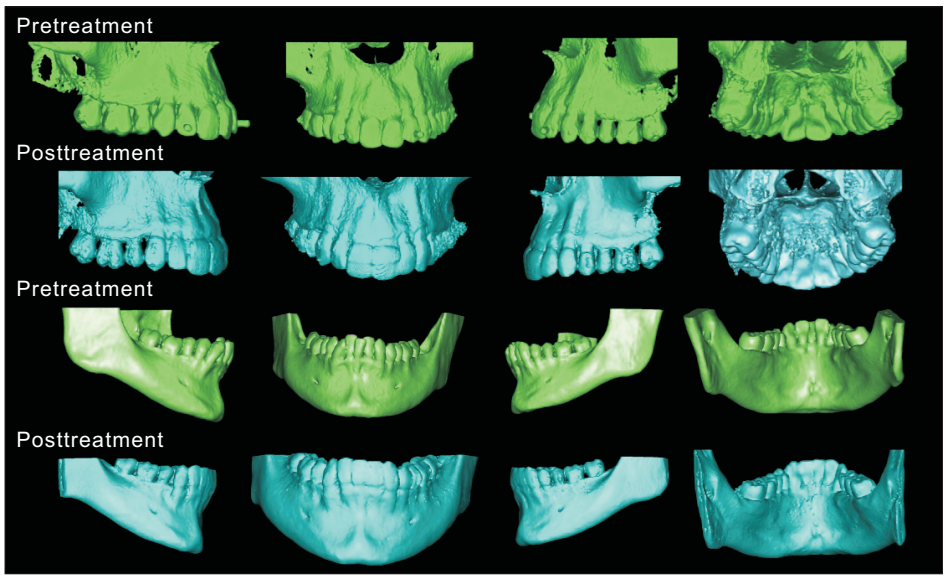

Figure 10. Three-dimensionally reconstructed images of pretreatment cone-beam computed tomography (CBCT) and posttreatment CBCT.

significant reduction in the radiographic height of the crestal bone and no evidence of any significant apical root resorption. This evidence was supported by the posttreatment CBCT findings that revealed no changes in the alveolar bone when compared to the pretreatment CBCT findings (Figure 10).

The OHIP-14 filled out by the patient before the treatment (T0), and 3 and 7 days after surgery had a total score of 11 points (T0 = 1; 3 days after surgery = 10; and 7 days after surgery = 0). A deterioration in OHRQoL was observed only after 3 days of surgery. An improvement in OHRQoL was also observed at the end of therapy (OHIP-14 = 0) than at the beginning of therapy (OHIP-14 = 1). The improvement in OHRQoL was also confirmed at the 2-year retention follow-up (OHIP-14 = 0).

DISCUSSION

In addition to the professional's considerations regarding the appropriateness and effectiveness of a treatment plan, addressing the adult patients' two most frequent demands for a reduction in treatment time and improved esthetics are a goal in the management of malocclusion.[2] In the case study described above, both surgical as well as orthodontic techniques were combined to meet those goals. The following paragraphs discuss both the surgical choices made, as well as the orthodontic approach adopted for treatment.

Corticotomy involves selective alveolar decortications in the form of lines and dots performed around the teeth that need to move. It is done to induce a state of increased tissue turnover and transient osteopenia, which is followed by a faster rate of orthodontic tooth movement.[5] In the present technique, the osteotomy cuts were performed using a piezosurgical microsaw without raising a mucoperiosteal flap.[6] The piezosurgical microsaw comes into contact with the soft tissue without causing damage.[6-8] While corticotomy is an accepted method to accelerate tooth movement, traditional techniques have often been considered rather invasive.[9] As described in the scientific literature, traditional corticotomy techniques imply full-thickness flap elevation, corticotomy cuts, and elective bone grafting.[4,9] These procedures are often time consuming (3 to 4 hours long), require oral and/or intravenous sedation, and carry undeniable postoperative morbidity and periodontal risks for the patient.[10-12] Dibart et al.[10,11] have popularized the concept of "piezocision"—a procedure that entails small incisions, minimal piezoelectric osseous cuts to the buccal cortex alone, and minimal bone or soft-tissue grafting.

More recently, Milano et al.[13] described a method for combining piezocision with computed tomography. After creating a 3D model of the arch, the corticotomies are planned and transferred to a resin surgical guide by using a numerically controlled milling machine. The main disadvantage of this technique is the laboratory phase, which could cause an error. Furthermore, the surgeon must add resin to stabilize the guide during surgery.[13] Unlike in the other previously described flapless corticotomy techniques, in the present technique, the cuts were made using a 3D-printed surgical guide that reduced the risk of damage to the anatomical structures. The possibility of virtually planning the incisions provides a safer means to selectively cut the bone and facilitate the preservation of root integrity. Indeed, in some interdental sites, the design and performance

of corticotomy can be based on direct visualization of the crown (as well as the corresponding imaginary longitudinal axis of the tooth), together with the tactile sensation of the interdental concavity between the root prominence.[14] However, when limitations such as root proximity, root convexity, or abnormal root angulations are present, the use of a surgical guide is the only way to maximize root safety.[6,7] Moreover, although full-flap elevation does entail increased morbidity for the periodontium, it does not add to the safety or precision of the procedure because tooth roots are still concealed by the cortical bone.

An adjunctive treatment to corticotomy described in the literature is alveolar augmentation with a demineralized bone graft to cover any fenestration and dehiscence, and to increase the bony support for both the teeth and the overlying soft tissues.[4] However, there is no evidence that bone grafting of the alveolus enhances the stability of the orthodontic result,[15] and in the present case, a piezocision technique, without bone grafts, was used successfully.

The potential repercussions of corticotomy on the periodontium must be evaluated.[6,7] It is imperative that an accurate periodontal diagnosis is established before treatment initiation and that periodontal checkups are regularly performed after surgery and throughout the period of orthodontic movements.[2] If periodontal disease is diagnosed at baseline evaluation, it must be appropriately treated and stabilized before commencing any orthodontic treatment. The present technique seems particularly indicated in adults with gingival recessions and a thin gingival biotype, because it does not interfere with the marginal periodontium, involves significantly less trauma to the periodontal tissues, and does not involve hard or soft-tissue grafting. In the present case, the patient showed good maintenance of interdental papillae, a reduction of PPD values, no reduction in crestal bone height, and no evidence of root damage at the end of the orthodontic treatment and at the 2-year follow-up. The improvement in the periodontal indices was stable because good oral hygiene could be maintained when the teeth were well aligned.

When responding to a traumatic stimulus, bony tissues initially pass through a biological stage called regional acceleratory phenomenon (RAP), which is characterized by a transient increase in bone turnover and a decrease in trabecular bone density.[16] Recent studies suggest that the length of RAP is approximately 4 months.[15] In view of this time limit and in line with the findings of other researchers,[2-6] the orthodontic treatment in the present case was started immediately after surgery.

Moving on to the orthodontic approach adopted, it was possible to complete the treatment in approximately one-third the time needed for the conventional orthodontic treatment, by combining the use of computer-guided piezocision and clear aligners. In this case, each aligner was retained for 5 days, rather than 15 days, for correcting the malocclusion and moderate crowding.[17] The corticotomy procedure has been reported to shorten the conventional orthodontic treatment time, and authors have claimed that teeth can be moved 2 to 3 times faster.[2,4] The current case findings confirm the previously published findings[2,4] and support this treatment option.

Currently, the long duration of a fixed orthodontic treatment may entail higher risks of caries and external root resorption, thereby decreasing patient compliance.[2] Clear aligners are relatively invisible, easy to insert and remove, and comfortable to wear. In the present case, the use of clear aligners resulted an improvement in the periodontal indices, with a relevant reduction of PPD in the lower jaw. This result may be attributed to the possibility of removing the clear appliance during oral hygiene, and to the effect of a reduced treatment time.

Nevertheless, clear aligners have some drawbacks. Djeu et al.[18] conducted a retrospective study comparing clear aligners with fixed orthodontic treatment. They found that esthetic clear aligners were especially deficient in their ability to correct anteroposterior discrepancies and occlusal contacts, thus demonstrating their limitation in overjet correction. Regarding the overbite value, Kravitz et al.[19] stated that the average true intrusion obtained using aligners in non-growing subjects was lower than the one obtained using the segmented arch technique. This may explain the minimal overbite correction observed in the present case (from 6.1 to 5.7 mm).

In terms of the effectiveness and appropriateness of using clear aligners, corticotomy speeds up the treatment and increases the scope of bone injury due to tooth movement, which, in turn, will initiate the previously mentioned RAP. This dynamic process, with its accompanying spurt of local activity (i.e., bone remodeling and surges in osteoclastic and osteoblastic activity), induces a state of transient osteopenia responsible for rapid tooth movement, because the teeth are moving in a more "pliable" environment.[10] As stated by Wilcko et al.,[9] given that corticotomy creates a more pliable bone, a fixed orthodontic wire might produce too strong an effect. When corticotomy is used to achieve faster orthodontic movement, the use of a clear aligner seems to be more appropriate to obtain greater control over orthodontic movement without the risk of losing the anchorage.

CONCLUSION

In conclusion, the present case study demonstrated the stability of an orthodontic treatment using a com-

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bination of computer-guided piezocision and clear removable aligners. The reduction of surgical time and patient discomfort, increased periodontal safety and patient acceptability, and accurate control of orthodontic movement without the risk of losing anchorage should encourage clinicians to consider this procedure as a valid alternative to other techniques in the treatment of moderate crowding. However, it must be highlighted that the efficacy of this combined approach must be confirmed by controlled clinical trials.

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