Treatment of Unilateral Condylar Hyperplasia with Proportional Condylectomy and Orthodontic Aligners

PIERO CASCONE, MD, PhD
BALDASSARE CICERO, DDS
VALERIO RAMIERI, MD, PhD
FRANCESCA GERMANÒ, DDS
VALENTINO VELLONE, MD

Unilateral condylar hyperplasia (UCH) is characterized by excessive growth of one mandibular condyle compared with the contralateral condyle. Affected patients develop facial asymmetry, often accompanied by occlusal discrepancies and disorders of the TMJ.[1] Although the etiology of UCH is still unknown,[2,3] some authors have hypothesized endocrine disorders, metabolic hyperactivity, trauma, arthrosis, and genetic causes as possibilities.[2]

UCH can occur at any age—before, during, or even after the growth period. While there is a predominance in females, no correlation has been demonstrated between the affected side and sex.[4] Clinical examination is considered the best way to diagnose UCH, supported by radiographs and single-photon emission computed tomography (SPECT) nuclear images. SPECT scans are especially useful in evaluating pathological bone metabolism, as characterized by more than a 10% difference in activity between the two condylar regions[5] (Fig. 1).

Various classification systems have been developed for UCH, generally based on clinical and radiological features and the location of excessive growth. According to Obwegeser and Makek,


Dr. Cascone


Dr. Cicero


Dr. Ramieri


Dr. Germanò


Dr. Vellone

Dr. Cascone is the Director and Drs. Ramieri and Vellone are maxillofacial surgeons, Maxillofacial Surgery Department, "Sapienza" University of Rome, Via del Policlinico, Rome, Italy. Dr. Cicero is in the private practice of orthodontics in Rome. Dr. Germanò is in the private practice of orthodontics in Rome; e-mail: francescagermano7@gmail.com.

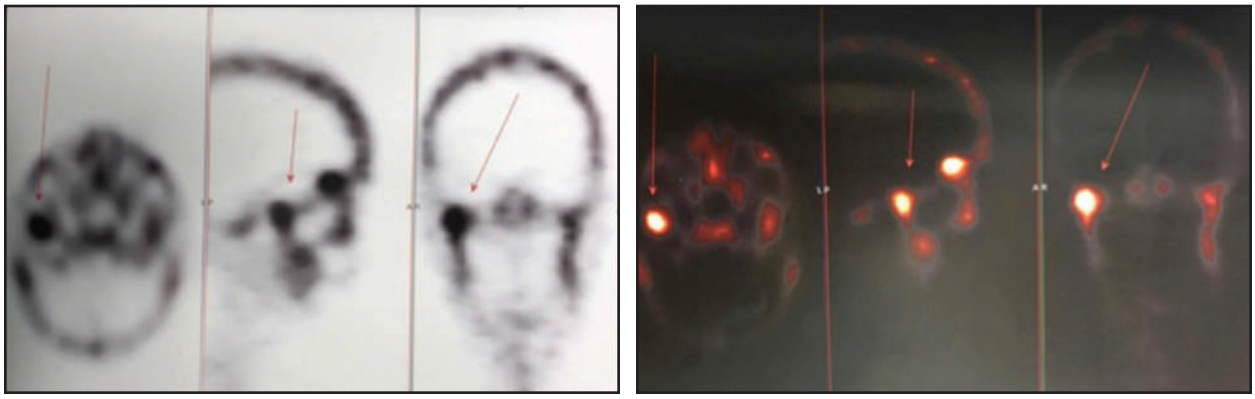

Fig. 1 Single-photon emission computed tomography analysis (polyphasic method) shows significant enhanced radioconcentration and hyperactivity in right TMJ during metabolic phase, evidencing isolated osteoblastic reac - tivity unassociated with either hyperemia or stasis.

hemimandibular hyperactivity can generate three distinct pathological types of unilateral asymmetry: hemimandibular hyperplasia, hemimandibular elongation, or a hybrid of the two.[6] Nitzan and colleagues differentiated condylar hyperplasia into vertical, transverse, and mixed forms, depending on various clinical criteria.[7] A third classification system, from Wolford and colleagues, is based on histological, clinical, and imaging characteristics and considers skeletal effects on the jaws and facial structures.[8]

Opinions differ regarding the optimal surgical treatment for UCH. Many consider high condylectomy to be the best treatment for active disease, with predictable results, but Farinã and colleagues observed that proportional condylectomy can reduce the need for secondary orthognathic surgery.[9,10] Orthodontic treatment remains controversial, with few studies available in the literature. This study was designed to investigate the effects of proportional condylectomy and functional arthroplasty,[11] followed by orthodontic therapy using clear aligners, as the sole method of treating UCH.

Materials and Methods

A retrospective analysis was conducted involving 14 patients who had been treated between 2013 and 2017. In each patient, UCH had been confirmed by a complete clinical examination for evaluation of facial symmetry, TMJ function, and occlusal conditions, along with photographic and radiological documentation including cone-beam computed tomography (CBCT). A positive SPECT with a differential of more than 10% between left and right condylar uptake was required for inclusion in the study.[5] Any patient who had received previous orthodontic treatment was excluded.

Hospital medical records were used to record each patient's age, sex, affected condyle, amount of removed condyle, SPECT uptake percentage, and facial and occlusal status. The 14 patients ranged from 15 to 42 years old (average 26.9). Nine were females and five were males; 50% were affected in the left condyle and 50% in the right one. Proportional condilectomy[9,11] with TMJ arthroplasty was the surgical treatment of choice. All patients were treated by the same maxillofacial surgeon and the same orthodontist. The surgeon and orthodontist consulted with each other to classify each patient's pathology as vertical, transverse, or mixed, according to the Nitzan criteria.[8] Of the 14 patients, nine (64%) were diagnosed as transverse types, two (14%) as vertical types, and three (21%) as mixed form.[7]

Extraoral, intraoral, and occlusal photographs (Fig. 2) were taken before surgery (T0), at the end of the main phase of orthodontic treatment (T1), and at the end of the refinement stage (T2).

Fig. 2 Typical UCH patients from this study. A. Case 1. 15-year-old female patient before treatment. B. Case 2. 29-year-old female patient before treatment.

CBCT imaging was requested for the T0 and T2 timepoints. The parameters analyzed at each timepoint were chin deviation, dental midline, occlusal canting, crossbite, and overbite.

The presurgical and post-treatment CBCT images were uploaded to Dolphin* software to enable precise measurements. Each image was reoriented on the Frankfort horizontal plane, and frontal, lateral, and panoramic x-ray images were built. In the frontal image, the facial midline was constructed as a line passing through Cg and ANS, perpendicular to the intersection of the cranial base line at the orbital margin (OM). Chin deviation was calculated as the angle from the facial midline to menton, and the dental deviation midline was measured as the difference in millimeters between U1 and L1.

The occlusal parameters of open bite, crossbite, and canting were classified as present or absent, based on the frontal, profile, and occlusal intraoral photographs. The functional TMJ parameters considered were maximum mouth opening (MMO) and contralateral movements, which were recorded at T0 and T2 using the BioPAK** version 7.2 kinesiographic examination.

Descriptive statistics for continuous and dichotomous variables were calculated with the R

*Dolphin Imaging and Management Solutions, Chatsworth, CA; www.dolphinimaging.com.
**Trademark of BioResearch Associates Inc., Milwaukee, WI; www.bioresearchinc.com.

statistical software system.*** Continuous variables were analyzed using paired t-tests, with a confidence interval of 95%.

Surgical Treatment

Before surgery, the CBCT image of each patient was exported as a Digital Imaging and Communications in Medicine (DICOM) file and transferred to SimPlant O&O,† which was used to simulate the virtual condylar osteotomy (Fig. 3). This determined the amount of condyle to remove and the postsurgical rotation with the contralateral condyle as a hinge.

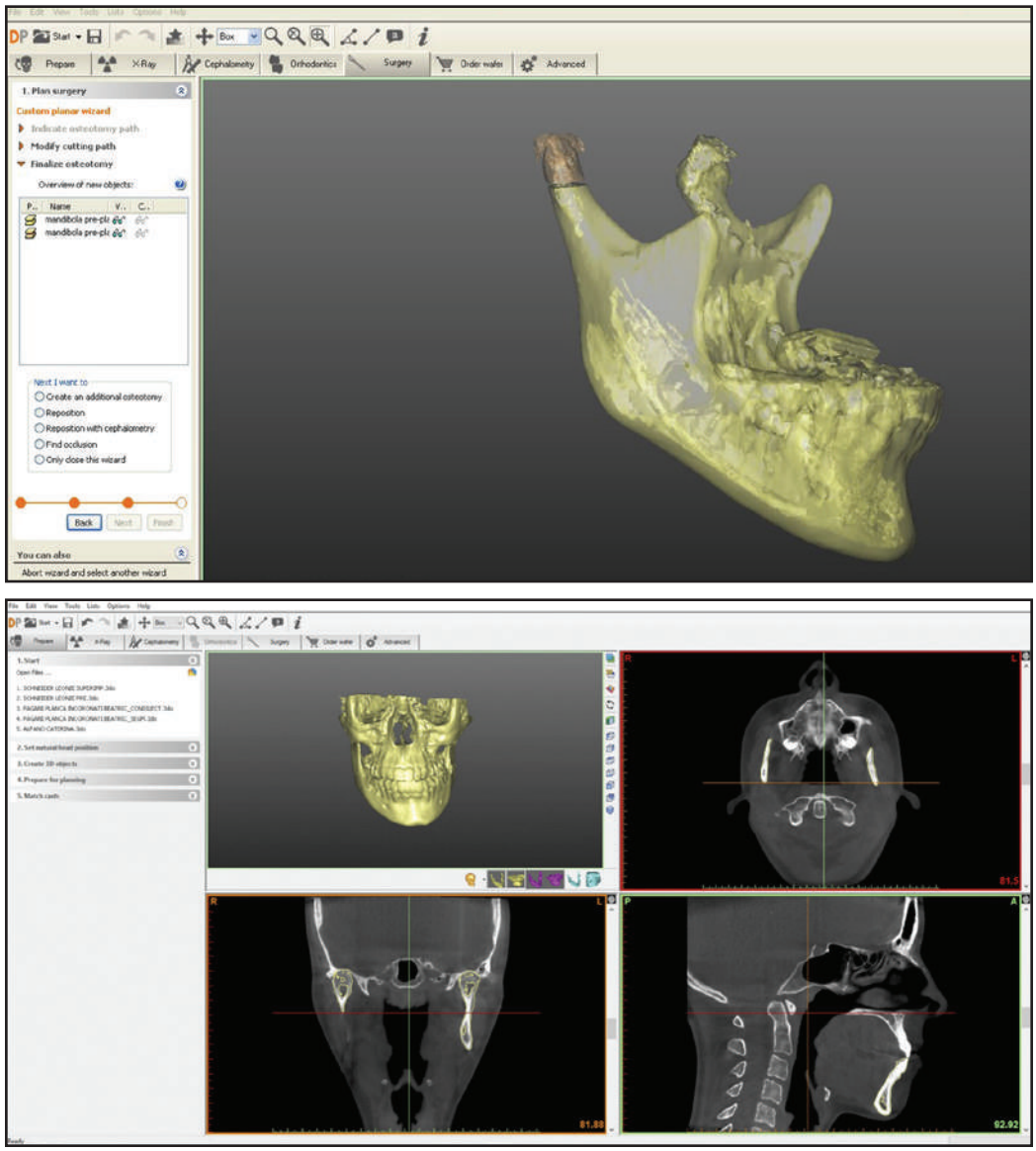

Fig. 3 Virtual simulation of condylar osteotomy.

The surgery began with a 1.5cm long preauricular, pretragal incision performed at a 45° inclination. The deep temporal fascia was reached by blunt dissection, allowing visualization of the articular capsule below. The temporal vessels were then isolated and cut. Once the TMJ capsule was reached, its lateral aspect was widely exposed. To allow surgical access to the inferior compartment while avoiding the superior compartment of the TMJ, the lateral ligament of the disc was detached 2mm above its insertion on the lateral aspect of the condyle. Three retractors were placed to expose the head of the condyle, thus improving visualization of the inferior joint compartment and protecting the disc, the retrodiscal tissue, and the medial aspect of the capsule from injury during the procedure.

A proportional condylectomy was performed through a piezoelectric device. As much of the condyle was removed as necessary to make the length of the active UCH-affected side equal to that of the contralateral condyle. The disc was tractioned laterally at the level of its insertion in the lateral ligament to restore it to its physiological position. The lateral ligament was then fixed to restore its physiological length, using a MICRO-FIX‡ QuickAnchor Plus1.3 assembly. A reabsorbable micro-anchor was positioned inside the condylar head and linked to a 3.0 Ethibond†† permanent suture, with which the posterolateral aspect of the disc was fixed above the condyle.

Orthodontic Treatment

The aim of the orthodontic treatment was to reach a stable and functional occlusion by removing dental compensations and by leveling and aligning the teeth over basal bone.

Before surgery, a digital intraoral scan was taken of each patient. The new arch positions were simulated, and a stereolithographic (STL) file was sent to the aligner company along with a bite registration, photographs, radiographs, and a prescription to create a virtual three-dimensional image. The technicians separated the individual teeth with customized software tools and used Treat‡‡ software to move the teeth into their final positions according to the prescription. ClinCheck§ was used to review and customize the treatment.[12] An STL file with the ultimate ClinCheck movements was transferred back to SimPlant to verify alveolar support of the dental roots. Once the case was confirmed by the treating clinician, the aligners were manufactured using a computer-aided design and manufacturing (CAD/CAM) process.

Treatment was started seven days after surgery to take advantage of the regional acceleratory phenomenon (RAP).[13,14] The aligners were changed every seven days during the first four weeks and every 14 days thereafter. Orthodontic buttons were bonded before surgery; during treatment, Class II intermaxillary elastics (3/16", 8oz) were worn on the side opposite the UCH, and Class III elastics on the affected side (Fig. 4).

The end of the first aligner sequence was considered the end of the main treatment period. Patients with more severe occlusal problems that had not yet been corrected were prescribed refinement aligners, which they wore only at night for about 12 months.

Results

The main phase of orthodontic treatment lasted an average 10.5 months, using a mean 18.5 sets of aligners. Six patients reached occlusal stability and acceptable TMJ function during the main phase. A refinement phase requiring an average 9.6 months and 15.8 sets of aligners was needed for the remaining eight patients (Fig. 5).

At T0, the average chin deviation was 5.35°. After orthodontic treatment (T2), a mean improvement of 1.28° (confidence interval 95%, range .515-2.056°) was seen. Chin symmetry was achieved in 71.4% (10 of 14) of the patients.

Before treatment, every patient showed a deviation of the lower dental midline from the facial

***Institute for Statistics and Mathematics, Vienna, Austria; www.r-project.org.
†Materialise, Plymouth, MI; www.materialise.com.
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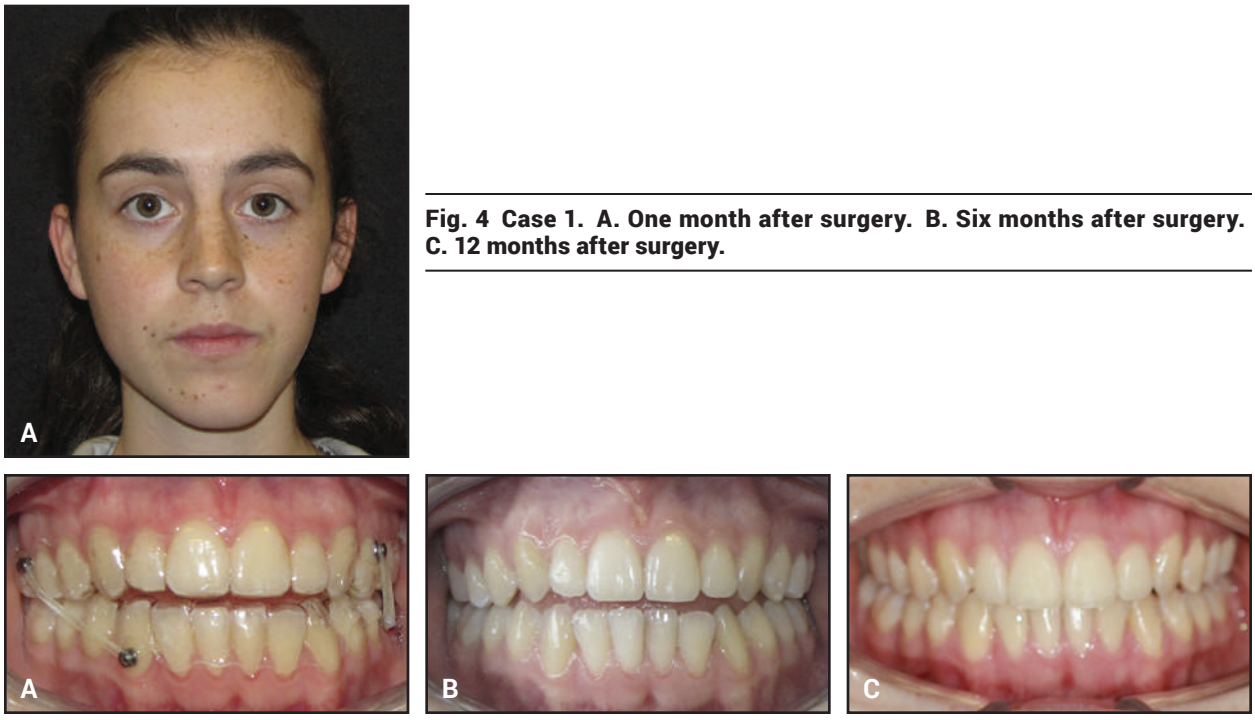

Fig. 4 Case 1. A. One month after surgery. B. Six months after surgery. C. 12 months after surgery.

midline toward the side opposite the UCH. At T1, an average correction of 1.43mm (95%, .794-−2.077mm) had been obtained; symmetry was improved in 71.4% of the patients, and 70% of these had reached a centered midline position. By the end of treatment, every patient had a centered midline.

At T0, 78.5% (11 of 14) of the patients exhibited canted occlusal planes. The cant was resolved in eight of those 11 patients after orthodontic treatment; the average improvement at T2 was .57% (95%, .27-.86%).

A crossbite was present in 28.5% (four of 14) of the patients at T0. The crossbite had been corrected in two of the patients at T1 and in all four patients at T2.

At T0, 42.8% (six of 14) of the patients presented with a lateral open bite. The open bite had been corrected in one of those six patients at T1, but four other patients developed lateral open bites that had not been present at the beginning. All patients exhibited normal occlusal relationships by the end of treatment.

An anterior open bite was seen in 21.4% (three of 14) of the patients before treatment. This problem had been corrected in one patient at T1, while another patient developed an anterior open bite that was diagnosed at T1. By T2, all patients showed normal occlusal relationships.

Before treatment, the average MMO was 31.7mm ± 6.4mm. By T2, the average MMO had improved to 38.1mm ± 1.6mm.

At T0, all patients had limitations in contralateral movement, with an average movement of 5.8mm ± 1.6mm. By T2, the average contralateral movement had improved to 9.3mm ± 1.6mm.

Discussion

UCH generally leads to occlusal imbalances and facial asymmetry.[2] Clinical observation will find progressive unilateral enlargement of the condylar head and neck, causing severe deviation of the chin and lower midline toward the contralateral side, as well as dentoalveolar compensation and

Fig. 5 A. Case 1. End of refinement phase. B. Case 2. End of refinement phase.

related soft-tissue changes.[3,7,15] Maxillary cant is also commonly associated with facial asymmetry.[16] These effects were substantiated by the study data we collected before surgery.

In the protocol demonstrated here, the proportional condylectomy corrected the mandibular asymmetry and halted condylar overgrowth. After the surgery, we were able to confirm that an open bite usually occurs on the unaffected side, and premature contact on the affected side.[7,17]

Postsurgical orthodontic treatment may be able to accelerate the spontaneous correction of dentoalveolar compensation.[18] Few studies have been published, however, on orthodontic treatment of UCH cases. One report of five patients found that mild to moderate asymmetry could be resolved during the inactive phase by condylectomy alone, without orthodontic therapy or other secondary corrections.[19] Other case reports have documented the use of traditional postsurgical orthodontic treatment to achieve acceptable occlusal stability and esthetics.[20,21] A retrospective study of 40 patients treated with postsurgical orthodontics found a reduction in the time required for maxillary alveolar and condylar remodeling.[22] In another case, a high condylectomy was followed by maxillary molar intrusion on the affected side, using temporary anchorage devices, to correct the malocclusion.[23] Intraoral miniplates were used to control the occlusion during postsurgical orthodontic treatment of another UCH case.[24]

To our knowledge, clear aligners have not previously been described as the sole means of orthodontic therapy after condylectomy. In the present study, all 14 patients started orthodontic treatment with bimaxillary aligners within one week after surgery. The aligners are not only esthetic, but they promote TMJ remodeling through both functional and orthodontic means. By incorporating and stabilizing all the teeth and inhibiting dental interferences and premature contacts, the aligners maintain free space and allow lateral and protrusive movements of the teeth toward the affected side. Intermaxillary elastics enhance this effect, leading to distraction of the condyle from the glenoid fossa, which permits mandibular displacement and subsequent muscular rehabilitation. After stabilization of the skeletal bases, the purely orthodontic phase of treatment involves only dental movement in three planes of space. Unlike traditional fixed orthodontic appliances, the aligner system does not depend on leveling of the arches by flattening of the curve of Spee, but enables different approaches in individual arch segments without involving other teeth. For example, unilateral intrusion can be accomplished while avoiding overeruption on the affected side.[25]

The main goals of the OCH treatment protocol presented here are to improve the occlusion and facial esthetics, reduce the chin deviation, and reestablish a level occlusal plane with a stable occlusion. As shown in this study, our approach can achieve satisfactory occlusal results within one year of treatment, although a refinement stage may be needed for orthodontic finishing.

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