Can Condylectomy Alone Achieve Facial Symmetry in Patients With Hemimandibular Hyperplasia (Condylar Hyperplasia Type 2)?

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Abstract: The purpose of the present study was to evaluate the 3-dimensional orofacial changes occurring after proportional condylectomy in patients with unilateral condylar hyperplasia type 2 (hemimandibular hyperplasia). Eight patients underwent proportional condylectomy that was not followed by orthognathic surgery or orthodontic treatment for at least 1 year. The precondylectomy and postcondylectomy photographs and radiographs were analyzed cephalometrically and compared. The average length of the condylar segment removed was 13 mm and this resulted in almost equal heights of the ramus-condyle units of both sides. Evaluations in the vertical plane improved after surgery; however, when the preoperative asymmetry was significant, the residual asymmetry continued to be notable after condylectomy. Transverse plane evaluations improved after condylectomy, and chin position was satisfactorily centralized in all patients. In the horizontal plane, mandibular setback occurred, and this was considered favorable when the preoperative skeletal profile was class III, whereas the opposite was when the patient was class I before surgery. The occlusion improved gradually over the postoperative months by the intrusion on the affected side and extrusion on the unaffected side into a bilaterally balanced posterior contacts with residual anterior open bite. In conclusion, condylar hyperplasia type 2 patients with mild asymmetry and low esthetic demands can benefit from proportional condylectomy as the sole treatment to both stop the hyperplastic condylar growth and improve the asymmetry to some extent. Surgeons should be able to predict the change that is expected to occur after proportional condylectomy and discuss this with the patient before surgery.

Key Words: Condylar hyperplasia, facial asymmetry, facial symmetry, hemimandibular elongation, hemimandibular hyperplasia, high condylectomy, orthognathic surgery, proportional condylectomy

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Condylar hyperplasia (CH) is a progressive overgrowth of the condylar growth site. Two main patterns of the disorder exist.[1–3] Type 1 CH, called hemimandibular elongation, is characterized by elongation of the condylar process and resultant transverse asymmetry of the mandible, manifesting primarily as a lateral mandibular shift off the midline. Type 2 CH, called hemimandibular hyperplasia, is characterized by diffuse unilateral enlargement of the mandibular condyle, ramus, and body, with the resultant asymmetry being primarily in the vertical plane. Both patterns cause secondary alterations of the maxillary dentoalveolus, occlusion, and soft tissue envelope of the face.[4,5]

The classic treatment for patients with active CH involves a form of high condylectomy (to arrest the condylar overgrowth) and orthognathic surgery (to correct the dentofacial deformity).[6–14] Few authors reported that when a more substantial segment of the condyle is ostectomized, so that the resultant heights of the ramus-condyle units on both sides are equalized, then in addition to arresting the condylar growth, a simultaneous 3-dimensional correction of the facial asymmetry is achieved.[15–24] As opposed to the high condylectomy, this procedure was termed proportional condylectomy.

The purpose of the present study was to evaluate the 3-dimensional orofacial changes occurring after proportional condylectomy in patients with CH type 2 (hemimandibular hyperplasia). We aimed to determine the change in the vertical, transverse, and horizontal planes and to assess which facial features improved or worsened after condylectomy, and to which extent.

PATIENTS AND METHODS

The medical records of patients with a diagnosis of unilateral CH type 2 (hemimandibular hyperplasia) who underwent proportional condylectomy at the main author's department were retrieved. Only patients who underwent proportional condylectomy that was not followed by orthognathic surgery or orthodontic treatment for at least 1 year were included in the

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study. Between September 2012 and September 2018, 8 patients fulfilled the inclusion criteria and represented the study sample. All patients included in the study were skeletally mature (females above 16 y, males above 18 y), and did not undergo any form of orthodontic or orthognathic treatment for at least 1 year after condylectomy. Patients with type 1 CH (hemimandibular elongation) or a mixed pattern CH were excluded from the study.

The diagnosis of active CH type 2 was based on the following criteria: patient's complaint of a progressive deviation of the jaw (s), asymmetric facies manifesting clinically and radiographically as an enlarged hemimandible (condyle, ramus, and body) with an inferiorly positioned mandibular lower border on the affected side and a cant of the maxillary plane inclined/tilted toward the affected side, with or without ipsilateral open bite, and bone scan with single photon emission tomography showing increased uptake of the suspected condyle ($>10\%$). Bone scans were evaluated by 2 independent nuclear imaging specialists.

As a routine practice in the department, patients seeking treatment for active CH were given the choice between 2 therapeutic options. The first option was to undergo proportional condylectomy to arrest the condylar overgrowth. Patients were educated that some degree of correction of the asymmetry could also be achieved. Orthognathic surgery would be considered ~12 months after the condylar surgery. This patient population was included in the present study. The second therapeutic option was to undergo a 1-stage procedure consisting of simultaneous high condylectomy combined with orthognathic surgery. These patients were not included in the present study.

The condylectomy procedure was performed under general anesthesia via an endaural incision without violating the superior joint compartment (Fig. 1). A sagittal electric saw (Stryker, Micro Core) and an osteotome were used. The height of the condylar segment removed was determined by matching the affected side with the healthy side on the panoramic radiograph (Fig. 2A), aiming to achieve equal heights of condyle-ramus units on both sides. The main author (W.A.) performed all operations. None of the patients included in the study underwent orthodontic or corrective surgery for at least 1 year after condylectomy.

Photographs (frontal at rest, profile, and occlusion) and radiographs (panoramic, frontal, and lateral), as well as file notes were retrieved from the medical documentations. To evaluate the efficacy of treatment, cephalometric analyses were performed on photographs and radiographs taken immediately before surgery and ~12 months after surgery. Six patients did not advance to orthognathic surgery and underwent an additional cephalometric analysis at a mean of 62 months postcondylectomy. Tracings and measurements were performed by 2 maxillofacial surgeons separately. An average was made when there was a difference between the 2 measurements.

Outcome parameters were categorized into: orofacial changes in the transverse plane, orofacial changes in the vertical plane, orofacial changes in the horizontal plane, and occlusal changes. Figure 2 and Supplemental Table 1 (Supplemental Digital Content 1, http://links.lww.com/SCS/E903) contain detailed description of the outcome parameters.

The study was approved by the ethical Institutional Review Board.

Statistical analysis: analyses were performed by SPSS software (version 24, IBM, SPSS Inc. Chicago, IL). Means and SDs of the independent variables were calculated. *t* tests were performed to compare the preoperative and postoperative values of each outcome parameter as paired continuous variables. A *P*-value <0.05 was considered significant.

RESULTS

The characteristics of the study population are presented in Supplemental Table 2 (Supplemental Digital Content 1, http://links.lww.com/SCS/E903). Outcome parameters were categorized into transverse, vertical, and horizontal cephalometric measurements and occlusal changes.

Vertical plane evaluations:

- Condyle-ramus height
  Preoperatively, the length of mandibular condyle-ramus unit on the affected side was 118.3% the length of the condyle-ramus unit on the unaffected side. Postoperatively, the length of the affected side decreased to become on average 99.4% of the length of the unaffected side ($P<0.001$) (Supplemental Table 3, Supplemental Digital Content 1, http://links.lww.com/SCS/E903 and Fig. 3).

- Vertical Gonial discrepancy:
  Preoperatively, the vertical distance from cranial base to Gonion on the affected side was 111.5% the length of the vertical distance from cranial base to Gonion on the healthy side. Postoperatively, this decreased to 104.5% ($P=0.016$) (Supplemental Table 3, Supplemental Digital Content 1, http://links.lww.com/SCS/E903 and Fig. 4).

- Discrepancy of mandibular lower border height:
  The discrepancy of the height between the right and left mandibular lower borders decreased after condylectomy by a mean of 5.38 mm, improving from a mean difference of 9.63 mm preoperatively to 4.25 mm postoperatively ($P<0.001$) (Supplemental Table 3, Supplemental Digital Content 1, http://links.lww.com/SCS/E903). However, when the preoperative discrepancy was significant, the postoperative asymmetry continued to be noticeable (Fig. 5).

- Lip commissure cant and maxillary plane cant:
  Lip commissure cant improved after condylectomy from a mean difference of 106.5% to 102.1% postoperatively ($P<0.001$) (Supplemental Table 3, Supplemental Digital Content 1, http://links.lww.com/SCS/E903 and Fig. 6). Maxillary plane cant improved from a mean of 106.3% to 103.4% ($P=0.016$) (Supplemental Table 3, Supplemental Digital Content 1, http://links.lww.com/SCS/E903).

Transverse plane evaluations:

- Clinical and radiographic chin deviation:
  The clinical chin deviation decreased from a mean of 3.81 degrees preoperatively to a mean of 1.69 degrees postoperatively. Similarly, the radiographic chin deviation decreased from 4.06 to 1.75 degrees. Both changes were statistically significant ($P=0.001$ and $P<0.001$, respectively) (Supplemental Table 4, Supplemental Digital Content 1, http://links.lww.com/SCS/E903 and Fig. 6).

- Clinical and radiographic lateral Gonial prominence:
  The clinical lateral Gonial prominence increased from a mean of 92.4% preoperatively to a mean of 102.4% postoperatively. In other words, preoperatively, the gonial area was on average relatively flat on the affected side and laterally prominent on the unaffected side). The radiographic lateral Gonial prominence similarly increased from 92.3% to 99.9%. Both changes were statistically significant ($P=0.019$ and $P=0.004$, respectively) (Supplemental Table 4, Supplemental Digital Content 1, http://links.lww.com/SCS/E903 and Fig. 6).

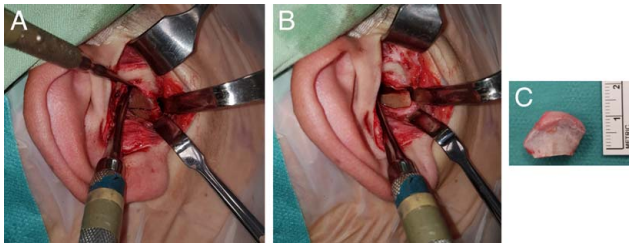

FIGURE 1. (A) The condylar head and neck were exposed via an endaural approach. The lateral ligament and joint capsule were elevated from the condylar neck from an inferior direction, thus the superior joint compartment was not violated. Note the ostectomy line. The residual condylar neck after condylectomy (B), the condylar segment (C).

Horizontal plane evaluations:

- Angle of facial convexity and S-N-Pog:
  Postoperatively, angle of facial convexity and S-N-Pog decreased from a mean of 169 and 87.1 degrees to a mean of 163.8 and 83.6 degrees, respectively ($P = 0.001$ and $P = 0.003$, respectively) (Supplemental Table 5, Supplemental Digital Content 1, http://links.lww.com/SCS/E903 and Fig. 5).

Occlusal evaluation:

- Preoperatively, some degree of open bite was present on the affected side in all patients but one. Immediately postoperatively, all patients developed premature contacts on the affected/operated side while developing anterior and contralateral open bite. The open bite was measured at the area of noncontacting opposing teeth with greatest vertical distance. Consequent follow-up evaluations showed that spontaneous intrusive forces on the affected side and extrusion of teeth on the unaffected side facilitated the gradual achievement of a more bilaterally balanced posterior occlusion and diminution of anterior open bite (Supplemental Table 6, Supplemental Digital Content 1, http://links.lww.com/SCS/E903 and Fig. 7). Some degree of anterior open bite, however, remained in all patients.

Overall satisfaction of the patients:

- One patient continued to complain of unevenness of the mandibular lower border and expressed her desire to correct this residual asymmetry with additional surgery (inferior border ostectomy). Another patient complained of the backward movement of the mandible after condylectomy. She shifted from class I to class II skeletal profile which was unesthetic. She was not interested in additional surgery to correct this deformity though. The other 6 patients were satisfied with treatment and the degree of correction and were not interested in any further corrective surgery.
- All patients regained their preoperative mandibular range of motion and function within 6 to 12 months after condylectomy.

Six patients had the records (photographs and radiographs) repeated at an average of 62 months after condylectomy. The values of this last evaluation were almost equal to the 12 months evaluation with no apparent continued change in cephalometric and occlusal measurements, so no statistical analysis was performed for this time point.

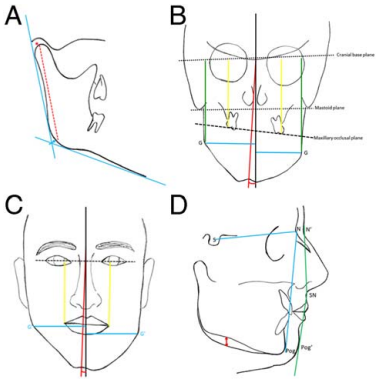

FIGURE 2. Cephalometric tracings. (A) Panoramic radiograph. The red asterisk indicates the condylion point (most posterior-superior point of condylar head). The blue arrow indicates the Gonion point (most posterior-inferior point of mandibular angle). The Gonion point was identified by drawing an angle bisector between the 2 blue lines, 1 tangent to the posterior border of the ramus, and the other tangent to the lower border of the body. The interrupted red line represents the condyle-ramus height (distance between Condylion and Gonion). (B) Frontal radiograph. The upper dotted line represents the cranial base plane (line between left and right intersections of medial orbital ridge and smaller wing of sphenoid). The lower dotted line represents the mastoid plane (line between left and right inferior-most points of mastoid bones). The vertical black line represents the corrected skeletal midline and is constructed by connecting the midpoint of the cranial base plane and the midpoint of the mastoid plane and extending the line to the chin. The red line is formed by connecting central chin point to central point of cranial base plane. The angle formed between the black and red lines is the radiographic chin deviation. The blue lines represent the distance of the Gonion (G) on each side to the corrected facial midline. The green lines represent the distance of the Gonion (G) on each side to the cranial base plane. The interrupted black line represents the maxillary occlusal plane, and the yellow lines represent the distance between the maxillary plane at the area of the second molar and cranial base plane, on each side. (C) Frontal photograph. The black line represents the corrected facial midline and is constructed by connecting soft tissue Glabella and center of filtrum and extending the line to the chin. The red line is formed by connecting central chin point to Glabella. The angle formed between the black and red lines is the clinical chin deviation. The blue lines represent the distance of the soft tissue Gonion (G′) on each side to the corrected facial midline. The interrupted black line represents the interpupillary plane, and the yellow lines represent the distance between interpupillary plane and lip commissures, on both sides. (D) Lateral radiograph. The blue lines form the angle between Sella, Nasion, and Pogonion points (S-N-Pog angle). The green lines form the angle of facial convexity, which is the angle between the soft tissue Nasion, Subnasale, and soft tissue Pogonion points. The red arrow represents the distance between the left and right lower borders of the mandible (discrepancy of mandibular lower border).

DISCUSSION

Some authors reported proportional condylectomy to be an effective sole treatment for active CH, achieving both arrest of the hyperplastic growth and gradual symmetry of the face.[15–24] In a recently published article by Abboud et al[25,26], the effectivity of proportional condylectomy as a single treatment to achieve symmetry in CH type 1 (unilateral hemimandibular elongation) was examined. The results clearly showed that while some facial and gnathic features improved, others actually worsened. In the present study we aimed to evaluate the 3-dimensional changes occurring after proportional condylectomy in CH type 2 patients (hemimandibular hyperplasia). The rationale was that while a postcondylectomy movement in 1 plane could be disadvantageous for a patient with transverse asymmetry (CH type 1) this same movement could be beneficial for a patient with vertical asymmetry (CH type 2), and vice versa.[14,27]

In the present study, all the vertical parameters (condyle-ramus height, vertical Gonioal discrepancy, discrepancy of mandibular lower border, lip commissure cant, and maxillary plane cant) improved after proportional condylectomy. As the

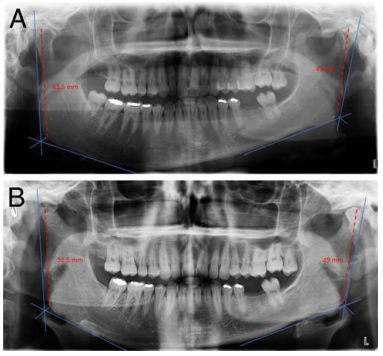

FIGURE 3. A patient with right hemimandibular hyperplasia. Measurement of the height of the condyle-ramus unit on the panoramic radiograph preoperatively (A) and postoperatively (B).

asymmetry in CH type 2 is primarily in the vertical plane, this may be regarded as a trivial outcome. The degree of improvement, however, was partial and when the baseline preoperative discrepancy was significant, though the patient improved, residual asymmetry remained relatively notable (Fig. 5C, D).

The length of the ostectomized condylar segment was 13 mm on average and this was translated to a mean correction of 5 mm in the inferior border of the mandible. After surgery, there is more dead space in the operated TMJ; however, the superior impaction of the ramus is impeded by the ipsilateral premature occlusal contacts. These premature contacts put the teeth on the operated side under intrusive forces. On the contralateral side, open bite develops and extrusion of teeth occurs.[28,29] This intrusive-extrusive process probably ends when the patient reaches a bilaterally balanced posterior occlusion, after which anterior open bite, if present, may remain indefinitely, and the gradual correction of the residual facial asymmetry does not continue.

After surgery, maxillary vertical cant was corrected by a mean of 3%, whereas the Gonial vertical cant was corrected by a mean of 7%. This may be explained by the fact that the postcondylectomy movement is not purely vertical, rather, whether the maxillary dentoalveolus is intruded vertically the mandible has an additional lateral vector that adds to the overall decrease in the vertical dimension in the Gonial area.[14]

Many authors reported using orthodontic elastics postoperatively to enhance achieving the balancing of occlusion.[15,16]

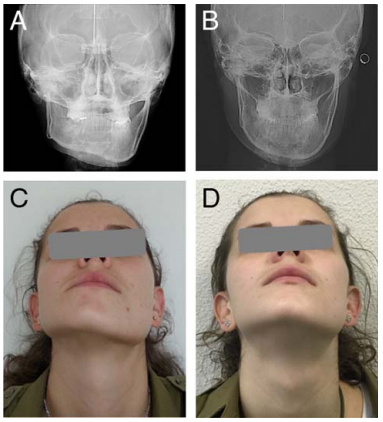

FIGURE 4. A patient with left hemimandibular hyperplasia. The vertical discrepancy of the Gonial area before (A) and 12 months after (B) condylectomy. A worm's eye view photographs before (C) and after (D) condylectomy demonstrating the improvement in vertical Gonial discrepancy.

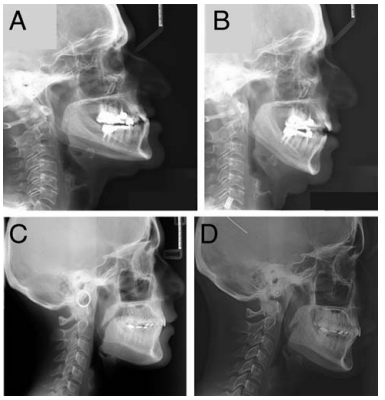

FIGURE 5. Lateral radiographs of 2 patients before and after condylectomy. The discrepancy of the mandibular lower border improved by 5 mm in both patients; however, although the patient in Figures A and B reached almost normal relations between right and left mandibular lower borders, the patient in C and D continued to suffer from a noticeable asymmetry in this area. Notice the slight mandibular setback with clockwise rotation occurring in both patients after condylectomy.

We believe that using elastics at the early postoperative phase indeed enhances the achievement of bilaterally balanced occlusion, however, on the expense of less intrusion on the operated/affected side. In other words, elastics enhance the extrusion of teeth on the unaffected side while unfavorably decreasing the intrusive forces and intrusion time on the affected side, which are very important for the correction of the maxillary plane cant. Clinicians willing to hasten the achievement of balanced bilateral occlusion while gaining intrusion of the maxillary dentoalvelous on the affected side should consider using orthodontic techniques utilizing bone anchors on the affected side.[30–34]

None of the patients achieved an optimal occlusion spontaneously, and orthodontic treatment was warranted. This issue should be discussed thoroughly with the patients before surgery. In addition, patients should be informed of the "noncomfortable" bite developing immediately after surgery, because from our experience, the malocclusion is the major postoperative complaint in the first 1 to 3 months.

In the transverse plane, chin deviation improved by a mean of 2 degrees. In addition, the lateral prominence of the Gonial area also improved, reaching a more equal Gonial lateral projection. This is because the Gonial area on the affected side was relatively flat in this patient population, and the lateral flare occurring after condylectomy served to increase the lateral projection of this area, thus correcting this asymmetry. We must note, however, that few patients with CH type 2 may present with equal lateral Gonial bulges on both sides or even an in-

FIGURE 6. Frontal photograph before (A), 6 months (B), and 12 months after (C) condylectomy. The chin deviation, lateral gonial prominence, and lip tilt improved significantly after surgery.

FIGURE 7. Occlusion of a patient with left hemimandibular hyperplasia before (A), immediately after (B), and 12 months after (C) condylectomy.

creased projection of the Gonial bulge on the affected side, in which case, the lateral propel after condylectomy will not improve the asymmetry, rather create or increase the Gonial discrepancy.

In the horizontal plane, a 4 to 5 degrees of setback of the chin occurred, thus improving the patient's average profile from class III toward a class I skeletal profile. Most patients with CH type 2 tend to have a straight or even concave skeletal profile; however, 1 patient in the present study had a preoperative class I skeletal profile and this setback moved her into a class II profile, which was considered unesthetic.

On the subjective level, most patients were satisfied with the esthetic and functional results; however, this did not necessarily correlate with the degree to which symmetry was attained objectively. A person's age, health, self-image, esthetic demands, and personal expectations from surgery have a profound effect on their overall satisfaction from treatment and their will to undergo further corrective surgery.[35]

Clearly CH type 2 patients with a minor degree of asymmetry or low esthetic demands should be given the option of proportional condylectomy as a sole surgical treatment for their problem. If they also have a straight or concave profile and a flat Gonial projection on the affected side, then the effects of proportional condylectomy would be even more satisfying. However, patients with significant deformity or high esthetic demands, or patients with a convex profile or a bulgy lateral projection of the Gonial area on the affected side, will probably require orthognathic surgery.

The main strength points of the present study are the strict inclusion criteria (CH type 2 only, in skeletally mature patients), the uniformity of surgical procedure, the consistent absence of postoperative orthodontics or orthognathics, and the standardized cephalometric measurements in the 3 planes. The main weakness point is the small number of patients.

In conclusion, proportional condylectomy could be a viable option to treat the select cases of CH type 2 (hemimandibular hyperplasia), given the patient and surgeon are fully aware of the advantages and the limitations of this treatment approach.

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