Hyperplasia of the Mandibular Condyle: Clinical, Histopathologic, and Treatment Considerations in a Series of 36 Patients

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Purpose: Mandibular condylar hyperplasia (CH) is a rare entity that causes overdevelopment of the mandible, creating functional and esthetic problems. The aim of this article was to describe demographic and clinical characteristics of CH, analyze histopathologic features and their association with scintigraphic and clinical findings, and evaluate esthetic and functional results after treatment by high condylectomy during the active phase.

Materials and Methods: This retrospective study included 36 patients whose condyles were removed because of excessive unilateral growth resulting in facial asymmetry and occlusal disturbance. Of the 36 patients, 13 had had symptoms related to the temporomandibular joint, such as pain or clicking. In all the cases, high condylectomy was performed, and surgical specimens were sent for histologic examination and divided into 4 histologic types as described by Slootweg and Müller. Statistical analysis was performed by use of R software (version 2.10.1; R Foundation for Statistical Computing, Vienna, Austria) and SPSS software for Windows (version 15.0; SPSS, Chicago, IL) to evaluate our results. A χ² test was carried out to assess the possible association between gender and involved side. The association of histologic appearance with clinical symptoms was estimated by use of the Fisher exact test. An analysis of variance test was performed to evaluate a possible association between patient age and histologic type according to the Slootweg and Müller classification and between histologic type and uptake on bone single photon emission computed tomography (SPECT).

Results: We could not find a relationship between histologic type and uptake of the affected condyle on bone SPECT or between age and histologic type. However, our statistical analysis revealed an association between histologic appearance and the presence of joint symptoms (P = .0049). Clinically, occlusion and facial symmetry improved in all patients postoperatively, and no recurrence was noted in any patient. Six patients required secondary surgery.

Conclusion: We could not find any significant association between age and histologic type or between bone SPECT and histologic type. However, a significant association between histologic type and temporomandibular joint symptoms was observed. High condylectomy combined with orthodontics achieved optimal esthetic and functional results and constituted the unique and definitive treatment in 30 of 36 patients.

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Mandibular condylar hyperplasia (CH) is a rare entity. It was first described by Robert Adams in 1836 as a condition that causes overdevelopment of the mandible, creating functional and esthetic problems. Since then, there have been numerous reports in the literature referring to this clinical entity. The excessive unilateral growth of the mandibular condyle can lead to facial asymmetry, occlusal disturbance, and joint...
dysfunction. Prominent features include an enlarged mandibular condyle, elongated condylar neck, outward bowing, and downward growth of the body and ramus of the mandible on the affected side, causing fullness of the face on that side and flattening of the face on the contralateral side. Some patients also may present with symptoms from the temporomandibular joint (TMJ) such as pain, joint sounds, and limitation of mouth opening.5

Obwegeser and Makek6 classified the asymmetry associated with CH into 3 categories: hemimandibular elongation, with a horizontal growth vector (type 1); hemimandibular hyperplasia, with a vertical growth vector (type 2); and a combination of the 2 entities. Type 1 is associated with chin deviation toward the contralateral side and mandibular midline deviated to the unaffected side. On the other hand, type 2 is characterized by an ipsilateral open bite or compensatory vertical overdevelopment of the maxilla on the involved side with canting of the occlusal plane. Most commonly, the mandibular midline is straight and the chin is less deviated. The third type is a combination of the other 2 types.

The etiology and pathogenesis of CH remain uncertain. It is not known what triggers a condyle to suddenly start growing and become hyperplastic. Suggested theories include trauma followed by excessive proliferation in repair, infection, hormonal influences, arthrosis, hypertrophy, and a possible genetic role.7–9 Obwegeser and Makek6 suggested that different growth factors individually controlling generalized hypertrophy and elongation might be responsible for the deformities. Another possible cause being taken into consideration, but thus far not substantiated, is an increase in functional loading of the TMJ10,11

The diagnosis of CH may be made by a combination of clinical and radiologic findings. Various methods have been used, including radiographic studies, bone scintigraphy, and histopathologic assessment.5,12 TMJ radiographs may show abnormalities in the size and morphology of the condylar head and/or neck regions. Bone single photon emission computed tomography (SPECT) scan is an essential diagnostic tool for visualizing hyperactivity in the condyle. Various studies have shown the clinical significance of this technique in such patients because this method identifies those with persistent unilateral condylar activity.5,13,14 The radioactive isotope is technetium 99 methylene bisphosphonate. Increased radionuclide uptake by the hyperplastic condyle can be an indication of continued abnormal growth. It has been reported that a difference in uptake of 55%:45% or more between the condyles can be indicative of CH, because the affected condyles had a relative uptake of 55% or more.15–17

Slootweg and Müller12 described 4 histologically different types of mandibular CH. They proposed a classification based on histologic criteria and divided hyperplastic condyles into 4 types depending on the arrangement and morphology of the various layers of the condyle (fibrous articular layer, undifferentiated mesenchymal proliferative layer, transitional layer, and hypertrophic cartilage layer).18 (Table 1).

Although most reported cases are documented histologically,5,12,19,20 in general, correlation of histologic aspects with age, SPECT, and clinical symptoms remains unclear.

Treatment is primarily surgical, with or without orthodontics, and depends on the degree of severity and the status of condylar growth. Different surgical options have been proposed for treating this anomaly, ranging from high condylectomy to orthognathic surgery or even a combination of both. There is also controversy with respect to the time of surgery, with some authors preferring to perform surgery as soon as possible and others waiting for cessation of excessive activity to perform any intervention.

### Table 1. Histologic Classification of Mandibular Condylar Hyperplasia Described by Slootweg and Müller12

<table>
<thead>
<tr>
<th>Histologic Classification</th>
<th>Characteristics</th>
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<tbody>
<tr>
<td><strong>Type I</strong></td>
<td>Broad proliferation zone</td>
</tr>
<tr>
<td><strong>Type II</strong></td>
<td>Patchy distribution (cell-rich areas alternating with nonproliferative, cell-poor zones)</td>
</tr>
<tr>
<td><strong>Type III</strong></td>
<td>Great distortion</td>
</tr>
<tr>
<td><strong>Type IV</strong></td>
<td>Continuous subchondral bone plate covered by cell-poor fibrocartilaginous layer</td>
</tr>
</tbody>
</table>

The aim of this retrospective study was to describe, in a group of 36 patients diagnosed with unilateral CH, demographic and clinical characteristics; analyze histopathologic features of CH and their association with scintigraphic and clinical findings; and evaluate our esthetic and functional results after treatment by high condylectomy during the active phase.

Materials and Methods

This retrospective study, which covered the period between 1998 and 2009, included 36 patients (25 female and 11 male patients) whose condyles were removed because of excessive unilateral growth resulting in facial asymmetry and occlusal disturbance.

The inclusion criteria for the study were: 1) patients with facial asymmetry and malocclusion, with or without pain or clicking related to the TMJ; 2) patients who showed enlarged and/or elongated condyles on the orthopantograph; 3) patients whose SPECT scan showed a difference in uptake of 55%; 45% or more between condyles or a large difference assessed subjectively by a specialist in nuclear medicine; and 4) patients in whom histopathologic examination confirmed mandibular CH.

Exclusion criteria included patients in whom enlargement of the condyle was caused by neoplasia or dysplasia, as shown by radiologic and histologic examination. All patients were informed of the nature of this investigation and all provided their informed consent.

Each patient had a complete clinical examination. The presenting clinical features in these patients included facial asymmetry and malocclusion. Moreover, 13 of the 36 patients had had symptoms related to the TMJ. In each case, these consisted of mild pain and clicking. Apart from the clinical examination, plain radiographs with orthopantographs and posteroanterior and lateral cephalograms were obtained. These showed enlarged and/or elongated condyles in most cases.

In all 36 cases, bone SPECT scans were performed. Patients who had a ratio of 55%-45% or more and clinical and radiographic findings in accordance with CH were operated on. A 6-month to 1-year patient evaluation period was sometimes required before surgery in cases in which condylar activity was uncertain. Exceptionally, 1 patient with an uptake of 54%-46% after several scintigraphic studies was treated surgically because of persistent and increasing symptoms after various evaluations.

In relation to the scintigraphic study, we must point out that only 24 of the SPECT scans were quantified. In the earlier cases, the planar and SPECT images were assessed only subjectively by a specialist in nuclear medicine.

In all the cases in our series, high condylectomy was performed through an intra-aural or preauricular approach, incision on the superficial temporal fascia and periosteum of the zygomatic arch, and dissection just above the TMJ capsule. Then, a T-incision was performed for entry in the inferior joint space, and 4 to 5 mm of the condylar head was removed, without smoothing of the cortical edges. Orthodontic treatment and mouth opening exercises were started thereafter.

All surgical specimens were sent for histologic examination. The condyles were first placed in 4% buffered formalin and then decalcified in hydrochloric acid (Surgipath Medical, Richmond, IL) and dehydrated sequentially in 70%, 90%, and 100% alcohol. Samples were cleared with 50% and 100% methyl salicylate before infiltration with paraffin. Micrometer sections were prepared from blocks, deparaffinized in xylene, rehydrated in descending concentrations of alcohol, and stained with hematoxylin-eosin. The samples were subsequently divided into 4 histologic types as described by Slootweg and Müller.

All the cases were confirmed histopathologically as CH, but only 18 were divided according to the Slootweg and Müller classification. We compared the histology of the condylar specimen with preoperative bone scintigraphy to try to find functional-morphologic correlations.

Statistical Analysis

Statistical analysis was performed by use of R software (version 2.10.1; R Foundation for Statistical Computing, Vienna, Austria) and SPSS software for Windows (version 15.0; SPSS, Chicago, IL). The level of statistical significance was set at .05. The descriptive statistical analysis was based on the mean and standard deviation for continuous variables, whereas the frequency and percentage were used for categorical variables. A \( \chi^2 \) test was carried out to assess the possible association between gender and involved side. The association of histologic appearance with clinical symptoms was estimated by use of the Fisher exact test. An analysis of variance (ANOVA) test was performed to evaluate a possible association between patient age and histologic type according to the classification of Slootweg and Müller and between histologic type and uptake on bone SPECT.

This study was approved by the Hospital Ethical Committee and by the Institutional Human Studies (IRB) Committee.

Results

The mean age at surgical intervention was 22.7 years (SD, 6.7; range, 11 to 42 years). The female-mal
ratio was 25:11, and the right-left affected side ratio was 11:7 (22 right and 14 left) from SPECT, histologically and clinically.

It has been suggested that there is an association between female gender and right side, with the right side predominating in female patients and the left side predominating in male patients. In our sample, we could not find a statistically significant association between gender and affected side.

All patients had unilateral excessive growth of the mandibular condyle with concomitant occlusal disturbance and/or chin deviation toward the opposite side. According to the clinical classification of Obwegeser and Makek, 24 patients were considered type 1 (66.7%), 8 patients showed an asymmetry in the vertical plane and were classified as type 2 (22.2%), and a combination of the 2 types was seen in 4 patients (11.1%). Additional symptoms, such as mild pain or clicking of the joint, were present in 13 cases (36.1%).

Bone SPECT scan had been performed on all 36 subjects. On all the scans, there was appreciable asymmetry in relative condylar uptake. The maximum difference among quantified scans was 68% to 32%. The mean percentage of the affected condyle was 59.04% (SD, 3.56), whereas the unaffected condyle showed a lower percentage (40.96%; SD, 3.56) (Table 2).

On examination of the histologic sections, all patients exhibited a persistent layer of undifferentiated mesenchyme cells and a layer of hypertrophic cartilage, and evidence of cartilage rests in the cancellous bone. Classification into types according to Slootweg and Müller was only performed in 18 patients.

Table 2. CLINICAL DATA OF 36 PATIENTS WITH MANDIBULAR CONDYLAR HYPERPLASIA

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age (yr)</th>
<th>Gender</th>
<th>Side</th>
<th>SPECT</th>
<th>Clinical Type*</th>
<th>TMJ Symptoms</th>
<th>Secondary Surgery</th>
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<tr>
<td>1</td>
<td>27</td>
<td>F</td>
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<td>—</td>
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</tr>
<tr>
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<td>24</td>
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<tr>
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<tr>
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<tr>
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<td>M</td>
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<tr>
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<td>20</td>
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<tr>
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</tr>
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<tr>
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<td>31</td>
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<td>R</td>
<td>57%:43%</td>
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<td>43%:57%</td>
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<td>36</td>
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<td>F</td>
<td>R</td>
<td>60%:40%</td>
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Abbreviations: C, combination of 2 clinical types; SPECT, single photon emission computed tomography; TMJ, temporomandibular joint.

*Clinical type according to classification of Obwegeser and Makek.

In our study, treatment for condylar hyperplasia was performed in 22 patients, with a mean follow-up period of 4.3 years. Occlusion and cephalometric evaluation were performed before and after surgery. High condylectomy left a maximum interincisal opening and lateral excursions (Figs 3, 4). Six patients required orthognathic surgery and esthetic surgery to correct residual deformity during the follow-up period (3 bimaxillary surgeries, 2 mentoplasties, and an angle prosthesis). Furthermore, we observed, in accordance with other authors, that the function of the joint was unimpaired and pain free.22 The clinical examination showed a normal maximum interincisal opening and lateral excursions before and after surgery. High condylectomy left a normally functioning joint. No long-term joint morbidity in patients treated in this way has yet been observed.

When analyzing our results, we observed that all the patients with type II CH presented with symptoms, such as pain and clicking. In type III patients, some had symptoms and some did not. Conversely, none of the patients with type I CH had any problems in relation to the TMJ. Our statistical analysis showed an association between histologic type and the presence of joint symptoms ($P = 0.0419$).

On the other hand, we could not find a relationship between histologic type and uptake of the affected condyle on bone SPECT.

The mean follow-up was 4.3 years. Occlusion and facial symmetry improved in all patients postoperatively, and no recurrence was noted in any patient (Figs 3, 4). Six patients required orthognathic surgery or esthetic surgery to correct residual deformity during the follow-up period (3 bimaxillary surgeries, 2 mentoplasties, and an angle prosthesis). Furthermore, we observed, in accordance with other authors, that the function of the joint was unimpaired and pain free.22 The clinical examination showed a normal maximum interincisal opening and lateral excursions before and after surgery. High condylectomy left a normally functioning joint. No long-term joint morbidity in patients treated in this way has yet been observed.

**Histologic types**

![Distribution of histologic types.](Image)


**Discussion**

Rowe2 defined mandibular CH as an entity that produces an asymmetry of the mandible resulting from an enlargement of one side that is not due to neoplasia or dysplasia.

Traditionally, it has been reported that CH affects male patients and female patients in equal proportions.23,24 Moreover, some authors have even indicated that this condition is more common in male patients.25 However, a female predisposition has been noted in other studies.26,27 and, indeed, our group included more female patients than male patients (ratio, 25:11), in agreement with other reports of ratios of 7:27 and 3:1.5,21 In light of our results, we can state that treatment was more commonly sought by female patients than by male patients.

With regard to preferential laterality, an equal side distribution has been found by some authors, whereas others have found that the left side is more frequently affected.20 In our study, the right side was more affected, with a ratio of 11:7 (22 right and 14 left). This result is consistent with other reports.21,27 Nitzan et al21 found that this preferential laterality was highly gender dependent, with the right side predominating in female patients and the left side predominating in male patients. Nevertheless, we have not found this association in our series.

With respect to clinical classification depending on the growth vector, a prevalence ratio between types 1 and 2 of approximately 15:1 has been reported.28 In our group of patients, this ratio was 3:1, and moreover, we found 4 patients with a combination of both vertical and horizontal asymmetry. Our results (type 1 in 66.7% of patients, type 2 in 22.2%, and a combination of transverse and vertical asymmetry in 11.1%) are similar to those of Nitzan et al,21 who reported frequencies of 53%, 31%, and 16% for type 1, type 2, and a combination of the 2 entities, respectively.

The scintigraphic results showed hyperactivity of one of the condyles consistent with clinical findings. It is important to emphasize that SPECT results should be interpreted in light of a full clinical, radiographic, and cephalometric evaluation. It should be borne in mind that this method of bone scanning, though highly sensitive, is nonspecific and does not necessarily correlate with active growth because it can also be the result of inflammatory conditions, infection, healing after traumatic injuries, and neoplastic lesions. Bone SPECT scintigraphy should not be used as the sole determinant of the need for condylar resection.

In describing the histologic characteristics of specimens of hyperplastic condyles that were surgically removed, similar to other authors,5,12 we have observed the presence of an interrupted layer of undifferentiated mesenchymal cells and a hypertrophic cartilage layer. Another
structural feature observed consistently in hyperplastic condyles is the distribution of cartilage rests in the subchondral spongiosa, which is histologic proof of progressive lengthening of the condyle.

Given the retrospective character of the study, although all the cases were confirmed histopathologically to have mandibular CH, only 18 were divided according to the classification of Slootweg and Müller.

In all the patients with increased radionuclide uptake, we observed the histologic characteristics of CH. However, when analyzing a possible association between the activity level of the affected condyle on scintigraphic examination and the histologic features of a determined type of CH according to the Slootweg and Müller classification, we could not find consistent results in our series.

Gray et al\textsuperscript{5} reported that the increase in uptake was directly related to the frequency and penetration depth of the cartilage islands. They also reported that those patients who had marked uptake on the scintiscan also had a higher frequency of cartilage islands, and the depth at which they were found was greater. However, they did not correlate these findings with histologic types.

Slootweg and Müller\textsuperscript{12} found that the results of scintigraphy did not correlate with histologic growth evidence. On the other hand, they assumed that there was a correlation between histologic growth activity and age, with type I being more frequently found in patients younger than 20 years of age and type II being more common in patients over 20 years of age. They indicated that type III would be more frequently

FIGURE 2. Histopathologic examination. A, Type I CH. The photomicrograph shows a broad proliferation area. Cartilage islands are present within the bony trabeculae (hematoxylin-eosin stain, original magnification $\times 20$). B, Cartilage island in deep layers of trabecular bone (4.6 mm deep from surface) of a hyperplastic condyle. C, Type II CH. Cartilage rests are less frequent in the spongy bone than in type I (hematoxylin-eosin stain, original magnification $\times 10$). D, Type III CH, showing more distorted layered pattern (hematoxylin-eosin stain, original magnification $\times 10$).

found in older patients. In our group, we tried to find an association between age and the various histologic appearances of the condyle, a statistically significant relationship was not encountered.

Nevertheless, we found a significant correlation between histologic type and the presence or absence of symptoms (P = .0049). Particularly, we observed that all patients with type II CH had clinical manifestations such as pain and joint sounds. Among the type III patients, some were symptomatic and the rest did not report any disturbance in relation to the TMJ. Conversely, none of the patients with type I CH had any joint symptoms. To our knowledge, this association has not been reported in the literature until now, and it could suggest that histologic types represent different stages of the pathologic entity, with the onset of symptoms as the illness becomes more evident and their disappearance as the fibrosis develops. Type I CH could be considered as a first phase of proliferation in which there are no symptoms yet. These would start in a latter phase (type II CH) of patchy activity, and patients would probably become asymptomatic again as the fibrosis generalizes and hyaline cartilage disappears (type III CH). However, because this study was conducted in a relatively small group of patients, the results cannot be generalized to the whole population of CH patients. They first need to be confirmed in further studies in larger series.

Traditionally, the surgical methods used have consisted primarily of orthognathic surgery for correction of the asymmetry when further growth is not anticipated. Motamedi performs unilateral or bilateral ramus osteotomy when growth is complete. Macintosh leaves the articulation surgically undisturbed, allows the hyperplasia to run its course, and then treats its sequelae with appropriate osteotomies. In our opinion, this option often means waiting a long time, and consequently, the patient may have functional and esthetic disturbances, associated with psychosocial problems derived from a severe facial deformity. Moreover, the magnitude of the deformity and its compensatory changes in the maxilla and dentoalveolar structures could compromise clinical treatment outcomes. Some authors perform a bimaxillary operation including resection of the involved condyle in the same procedure. Wolford et al. and Sheffer et al. propose orthognathic surgery and simultaneous condylectomy to correct the asymmetry.

In our opinion, basic considerations in the management of facial asymmetry caused by active CH must include control of the growth process to allow more balanced facial development. If evidence of abnormal condylar growth is present, then condylectomy should be undertaken before a severe facial deformity develops. It is expected that the removal of the condyle will arrest the excessive and disproportionate growth of the mandible in the diseased region and
can therefore limit progressive asymmetry during the active phase and provide stable long-term results. Orthodontic treatment after surgery can correct occlusal and esthetic deformity definitively without additional surgical interventions in most cases. If not, secondary correction by mandibular or maxillary osteotomies or both can be appropriate to correct any residual occlusal and facial asymmetry. In general terms, if a high condylectomy has been performed and posterior orthognathic surgery is necessary, this second operation will be easier.

High condylectomy (removal of 4 to 5 mm of the condyle) instead of condylar shaving (removal of 2 to 3 mm of the condyle) is our preferred method. The presence of cartilage islands in the cancellous bone shows that the pathology is not limited to the cartilage surface. Masses of hyaline cartilage extending into the cancellous bone of the condylar neck have been identified in our samples. Therefore, not only the cartilage surface but also the subchondral bone should be removed to eliminate the growth center.

In summary, we could not find any significant association between age and histologic type or between bone SPECT and histologic type. However, a significant association between histologic type and TMJ symptoms was observed. High condylectomy combined with orthodontics achieved optimal esthetic and functional results and constituted the unique and definitive treatment in 30 of 36 patients.

Acknowledgments

The authors thank Dr. Fernandez de Mera for the histologic analysis.

References

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