Pathologic Facial Asymmetries

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Facial asymmetries may be the result of developmental, traumatic, inflammatory, and pathologic processes. Neoplastic and nonneoplastic pathologic processes of the oral and maxillofacial complex may be responsible for the development of significant facial asymmetries. Such asymmetries may represent diagnostic dilemmas for the surgeon in ascertaining their cause. This problem may be overcome by obtaining an extensive history, performing a complete physical examination, and acquiring special radiographic studies.

For the purpose of this discussion, pathologic facial asymmetries are designated as either primary or secondary. Primary pathologic asymmetries are those where the anatomic location of the pathologic process and the facial asymmetry are identical. Secondary pathologic asymmetries of the face are those where the anatomic location of the pathologic process and the asymmetry distinctly are different. Perhaps the most notable examples of the latter are benign pathologic processes of the mandibular condyle. In such cases, benign tumor growth or nonneoplastic growth of or about the condyle results in either deviation of the chin to the contralateral side resulting in a horizontal facial asymmetry, or a downward growth of the ramus and body of the mandible resulting in a vertical facial asymmetry. Primary and secondary pathologic facial asymmetries have several additional differences that are summarized in Table 1.

PRIMARY PATHOLOGIC ASYMMETRIES

The ability of any pathologic entity to create a primary pathologic asymmetry of the face is directly related to the doubling time of the tumor, as well as its violation of surrounding anatomic barriers following the development of a critical tumor load. It becomes clear that these two parameters are not mutually exclusive. The principles of anatomic barriers perhaps are best described in terms of those tumors that originate centrally within the mandible. The odontogenic tumors, most notably the ameloblastoma, serve quite satisfactorily in illustrating the invasion of anatomic barriers, as well as providing a general guide for benign tumor surgery of the jaws.

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### Table 1. CHARACTERISTICS OF PRIMARY AND SECONDARY PATHOLOGIC FACIAL ASYMMETRIES

<table>
<thead>
<tr>
<th>Primary</th>
<th>Secondary</th>
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<tr>
<td>The pathologic entity and the asymmetry are located in the same anatomic area.</td>
<td>The pathologic entity and the asymmetry occur in different anatomic areas.</td>
</tr>
<tr>
<td>The pathologic process may be nonneoplastic or a benign or malignant tumor.</td>
<td>The pathologic process usually is nonneoplastic or a benign tumor, but rarely a malignant tumor.</td>
</tr>
<tr>
<td>The development of facial asymmetry may be slow (benign) or precipitous (malignant).</td>
<td>The development of facial asymmetry usually is slow.</td>
</tr>
<tr>
<td>The radiographic appearance of the pathologic process is variable in its quality as well as its location in the facial region.</td>
<td>Radiographs usually illustrate a well-defined, radiopaque, productive process about the condyle.</td>
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### Benign Tumors

The ameloblastoma is a benign odontogenic tumor of completely epithelial origin. No matter what theory of cellular origin the surgeon considers most valid, it is well accepted that the multicystic or solid variant of the ameloblastoma arises centrally within the medullary component of bone. Initially, the tumor develops a radial or longitudinal growth within the medullary component of mandibular bone. Thus, the first anatomic barrier that the mandibular ameloblastoma encounters is the cortical bone. The cortical bone is a very robust anatomic barrier that is able to enclose the developing tumor, in many cases restrict growth, and therefore forestall the development of facial deformity and asymmetry. Unfortunately the persistent and aggressive growth of the ameloblastoma ultimately results in the anatomic barrier of cortical bone “giving way” to the advancing tumor. Once cortical bone has been perforated by this tumor, the less robust anatomic barrier of periosteum readily is violated. Although this information is very important for the tumor surgeon and may be elucidated by CT scans as well as by physical examination, the concept of compact bone penetration by the ameloblastoma has been challenged. Gardner stated that the inferior cortex of the mandible can be left intact owing to his belief that the ameloblastoma does not invade compact bone. The experienced odontogenic tumor surgeon will be quick to point to the inaccuracies of this statement, pointing to multiple personal cases that clearly demonstrate radiographic and histologic invasion of cortical bone. Based on my own experience, I would rephrase Dr. Gardner’s statement in the context of the anatomic barrier principles. With these principles in mind, it is clear that the cortical bone of the mandible is a very competent anatomic barrier but becomes invaded by tumor once a critical tumor volume is reached (Fig. 1). The anatomic barriers of muscle, fat, and mucosa are able to be invaded by tumor following violation of periosteum and submucosa, a concept that, for the most part, remains noncontroversial (Fig. 2).

The misconception that the ameloblastoma does not invade compact bone probably has illegitimately offered many surgeons hope to cure patients with enucleation and curettage procedures. Unfortunately, the recurrence rate for solid or multicystic ameloblastomas treated by enucleation and curettage is high, varying between 55% and 90% in various series. The rate of recurrence of maxillary ameloblastomas treated in this fashion has been reported as 100%. Gardner is quick to point out that these figures reflect the ameloblastoma’s aggressive property of infiltrating cancellous bone well beyond the tumor’s clinical and radiographic margins. In tumors that seem to be confined to the medullary component of bone by imaging studies, it is their microscopic infiltration of cortical bone that results in ineffective local control and eventual recurrence after treatment by enucleation and curettage. It seems clear that enucleation and curettage, in contrast to more extensive resections, is not a reliable method of curing the solid or multicystic ameloblastoma. This notwithstanding, recommenda-
Figure 1. A, B. A 62-year-old patient displays a primary pathologic asymmetry due to a large ameloblastoma of the mandible that has perforated the buccal cortex of the mandible. C. Physical examination reveals the violation of many anatomic barriers in the oro-facial region, including oral mucosa. An adequate history indicates that the patient originally sought consultation from another surgeon 6 years earlier, at which time a panoramic radiograph was obtained (D).

Illustration continued on following page
Figure 1 (Continued). No treatment was rendered at that time. E, Six years of slow, yet persistent, benign growth produced this radiographic presentation. At this point, the tumor is noted radiographically to have infiltrated the inferior border of the left mandible. The roots of the anterior teeth are resorbed and are literally floating in the tumor. This patient consented to an extensive mandibular resection.
Figure 2. Axial CT scan of the patient in Figure 1. This tumor has infiltrated and destroyed the anatomic barriers of buccal and lingual cortex of the mandible, periosteum, mentalis muscle, and subcutaneous fat. Such advanced extension into the anatomic barriers is responsible for this patient's primary pathologic asymmetry. The anatomic barrier of skin is not violated by this benign tumor because the regenerative capacity of the epidermis is much quicker than the cellular turnover of benign tumors.

tions have been made for specific anatomic sites where enucleation and curettage are indicated. A small tumor of the body of the mandible is such a site that Gardner believes may be curetted provided that the surgeon is aware of the high risk of recurrence and is able to follow the patient closely for 10 years or more. He also suggests that patients in the third or fourth decades of life be treated in this manner because it may be years before a second operation is necessary. It is this author's opinion that young patients and patients of any age with small tumors are exactly the patients who should be treated aggressively with cure as the goal (Fig. 3). No tumor surgeon should intentionally treat a healthy and consenting patient in a compromised fashion, knowing full well that the tumor is likely to recur, merely to preserve continuity of their jaw. This is true particularly in light of the fact that the ameloblastoma is a very curable tumor when treated by resection and all margins histologically are negative. Moreover, the predictable nature of mandibular reconstruction with cancellous cellular marrow should provide the surgeon confidence in performing continuity resections of the mandible, taking pride in the fact that such continuity defects can be reconstructed successfully and predictably when proper scientific principles of bone grafting are followed. The case need not be belabored. The maxillofacial tumor surgeon's ability to eradicate a benign jaw tumor effectively and permanently comes to rest on an understanding of the anatomic barrier principles. An appreciation for these principles results in the sacrifice of at least one uninvolved anatomic barrier on the tumor specimen, thereby ensuring a true en bloc removal of the tumor with a high likelihood of negative histologic margins.
Figure 3. A, Radiographic extent of a very small biopsy-proven ameloblastoma of the left mandible. Although an enucleation of this tumor might seem reasonable due to the small size, such conservative treatment would likely result in a recurrence at a time when the patient could have been treated with a resection, bone grafted on a delayed basis, and dentally rehabilitated. The author treated this patient with a continuity resection with 1-cm bony margins. The specimen (B) and the specimen radiograph (C) are shown.
Malignant Tumors

Malignant tumors of the oral and maxillofacial region are responsible for significant facial deformities. Although both benign and malignant tumors of the oral cavity and face may create facial asymmetries, such facial disharmonies occur more commonly owing to malignant tumors as a result of more sophisticated cellular kinetics. Malignant tumor cellular kinetics are able to be observed clinically because untreated malignancies grow more quickly than their untreated benign tumor counterparts (Fig. 4).

Tissues and organs consist of populations of cells held together by collagen. The growth of tissues and organs may occur by an increase in the number of cells, an increase in the size of cells, or both. In animals, growth in numbers usually predominates over growth in size, although some growth in size occurs in normal and neoplastic growth.

Figure 4. A, A stage IV squamous cell carcinoma of the floor of mouth and alveolar ridge. The patient refused all forms of therapy. B, The patient returned 4 months later. This tumor’s doubling time proved to be less than 4 months, which is indicative of this malignancy. The doubling time of this squamous cell carcinoma is significantly less than that of benign tumors, such as the ameloblastoma in Figure 1, whose doubling time was probably on the order of 5 years.
In every population of cells there are three subpopulations that may exist simultaneously (fig. 5). The first group is cycling cells that proliferate continuously, going from one mitosis to the next. The second group is composed of terminally differentiated cells that irrevocably leave the cell cycle and are destined to die without dividing again. The third subpopulation of cells are nondividing and noncycling (G_0). Such G_0 cells are normally present in the human. In the adult liver, for example, most of the cells are in G_0. If two thirds of the liver is removed surgically, for example, the remaining liver cells quickly resume the cell cycle, proliferate, and restore the liver to near its original size. Other G_0 cells in the human body include the stem cells of the bone marrow. These stem cells are capable of reproducing themselves and of producing all the different lineages of hematopoietic cells from megakaryocytes to lymphocytes to erythrocytes. Their status as G_0 cells is fortunate because it protects them from chemotherapeutic agents used to treat various cancers. The bone marrow depletion caused by chemotherapy has a mitogenic effect on the protected stem cells, which re-enter the cell cycle and eventually repopulate the bone marrow.

Most tumors grow in size by any or all of the following mechanisms: shortening the length of the cell cycle, resulting in more cells being produced per unit time; decreasing the rate of cell death; and moving G_0 cells into the cell cycle, also resulting in more cells produced per unit time. In most tumors, these three mechanisms are important in determining the aggressiveness of the tumor, which is best characterized by its doubling time. The doubling time of any tumor is a real measure of its aggressiveness, providing a better index of aggressive behavior than the mitotic index or the degree of anaplasia observed microscopically. The doubling time of a tumor simply is the time required for the cell number to double in size. In conceptual terms, the doubling time is a parameter of growth that is relatively simple to measure in human tumors and is related to the tumor’s clinical behavior, as well as its ability to create facial disfigurement and asymmetry. The minimum detectable body burden of tumor in humans generally is of the order of 1 x 10^6 cells (approximately 1 g of tissue), which translates to approximately 30 doublings. The lethal body burden of tumor in humans is believed to be approximately 1 x 10^{12} cells (1 kg of tumor). Considerable variability exists, however, depending on the type and location of a specific tumor including its metastases. When the onset of gestation to diagnosis of a tumor is known, the average subclinical tumor doubling time can be calculated. In breast cancer, for example, the average time elapsed from mastectomy to the appearance of a tumor nodule in the surgical scar is 750 days. This information can be used to calculate the subclinical tumor doubling time as

750 days / 30 doublings = 25 days.
Table 2. MEAN CLINICAL DOUBLING TIMES OF SELECTED HUMAN TUMORS

<table>
<thead>
<tr>
<th>Tumor Type</th>
<th>Doubling Time (days)</th>
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<tr>
<td>Burkitt's lymphoma</td>
<td>2−5</td>
</tr>
<tr>
<td>Testicular cancer</td>
<td>21</td>
</tr>
<tr>
<td>Ewing's sarcoma</td>
<td>22</td>
</tr>
<tr>
<td>Non-Hodgkin's lymphoma (predominantly large cell)</td>
<td>25</td>
</tr>
<tr>
<td>Osteogenic sarcoma</td>
<td>34</td>
</tr>
<tr>
<td>Hodgkin's disease</td>
<td>38</td>
</tr>
<tr>
<td>Small cell carcinoma, lung</td>
<td>81</td>
</tr>
<tr>
<td>Squamous cell carcinoma, lung</td>
<td>87</td>
</tr>
<tr>
<td>Adenocarcinoma, colon</td>
<td>96</td>
</tr>
<tr>
<td>Adenocarcinoma, breast</td>
<td>129</td>
</tr>
<tr>
<td>Adenocarcinoma, lung</td>
<td>134</td>
</tr>
</tbody>
</table>

This calculation assumes that only a single cell was deposited in the incision at the time of the mastectomy, which, of course, may not be accurate. Representative clinical doubling times for a variety of solid tumors, some of which occur in the head and neck region, are noted in Table 2.

Further observations in the kinetics of tumor growth indicate that human tumors, including malignancies, undergo growth retardation in advanced states of growth. The question arises as to how slowly growing malignancies and advanced malignancies that display growth retardation can be distinguished based on cell kinetic data alone. In operational terms, slowly growing tumors undergo much of their growth retardation when they are still below the level of clinical detection. When such doubling times are measured, for example, they are noted to be relatively long. Rapidly growing tumors are defined as those that maintain their subclinical doubling times well into the clinically detectable range of tumor sizes. Burkitt's lymphoma, a rapidly growing tumor, has a subclinical doubling time of approximately 6 days, and an early clinical doubling time in the range of 2 to 5 days.

Two additional features of malignant tumor kinetics are worthy of mention. The first centers around the relationship of tumor growth and response to therapy. Clinical experience has shown that rapidly proliferating tumors in humans are more responsive to systemic therapy than are slowly proliferating tumors (Fig. 6). The increased susceptibility of rapidly proliferating cells to cytotoxic drugs also has been demonstrated in numerous experimental tumor cell systems. It might be expected that the proper application of the principles of cell kinetics will result in more effective forms of cancer treatment. Considerable interest has developed in recent years in clinical pro-

Figure 6. A, A 9-year-old patient with a fast-growing lymphoblastic lymphoma of the left mandible and neck. B, After only two cycles of chemotherapy, the tumor was nearly undetectable clinically.
tocols that have been designed with cell kinetics in mind. Therapeutic regimens using late-treatment intensification and newer therapeutic approaches to the problem of emergence of genetic drug resistance have relied on basic kinetic concepts of tumor growth and drug response.  

Finally, at least a clinical correlation seems to exist between the kinetics of malignant tumors and the incisional biopsy used to establish their diagnosis. In particular, it has been my observation that many head and neck malignancies undergo a geometric growth phase following incisional biopsy. Whether this increased growth is owing to G1 cells entering the cell cycle, or an increase in the M phase, however, is unclear.

SECONDARY PATHOLOGIC ASYMMETRIES

Secondary pathologic asymmetries of the face are the result of both neoplastic and nonneoplastic entities that develop distant to the site of the asymmetry. The development of such deformities stems from the fact that most if not all of these processes are benign, and therefore result in the production of nonneoplastic hard tissue or tumor in or about the condyle. Through destruction of the temporomandibular joint region, malignancies of the condyle conceptually would be responsible for facial asymmetries; however, this is not observed clinically as commonly as occurs with benign processes.  

The evaluation and diagnosis of a patient with a radiographically abnormal condyle is crucial in order to provide the most appropriate form of surgical therapy for the patient. The radiographic configuration of the unilateral enlarged mandibular condyle may isolate the pathologic diagnosis. In general, the condyle that otherwise appears normal in shape, yet has an obviously elongated condylar neck, is considered hyperplastic. An irregular, morphologically distorted condyle generally is neoplastic and most commonly benign. Although the distinction between condylar hyperplasia and condylar tumors is predicated to a major extent on histopathology, the morphologic distinction herein clinically is important because it is the determining factor insofar as the specific type of condylar surgery that is dictated to treat each category of condylar pathology. A review of the features of condylar hyperplasia and benign condylar tumors follows.

Condylar Hyperplasia

Although the cause and pathogenesis of condylar hyperplasia are far from elucidated, it is generally accepted that this process is owing to a persistent or resumed activity of the precartilaginous cells of the condylar growth zone at a time when skeletal maturity has already been reached. Various presumed causes have been suggested, including neurotrophic disturbances, local circulatory disturbances, previous trauma, partial hemihypertrophy, arthrosis, forme fruste of multiple osteochondromatosis, hormonal disturbances, and true neoplasia. Whatever the cause, the basic pathophysiology of condylar hyperplasia centers around the histologic presence of hyaline cartilage that undergoes enchondral ossification resulting in growth of the mandible and ultimately the development of facial asymmetry. This is in distinction to the fibrocartilage of the nongrowing condyle, which undergoes appositional growth instead of enchondral ossification.

The facial deformity that occurs in condylar hyperplasia has been reported to be of two types. Toller has described type I, which is the most common type, and manifested by asymmetry of the mandible owing to a deviation of the chin to the contralateral side. There is a concomitant dental cross-bite owing to the skeletal deformity. Obwegeser and Malek have designated Toller's type I condylar hyperplasia as hemimandibular elongation. The type II deformity described by Toller is manifested by a downward bowing of the mandible on the ipsilateral side with the development of a vertical dental open bite. This deformity has been referred to as hemimandibular hypertrophy by Obwegeser and Malek.

Regardless of the specific type of condylar hyperplasia, surgery should be di-
rected at eliminating the abnormal growth zone as well as correcting the associated facial deformity. Of importance in treating patients with condylar hyperplasia is an understanding that this nonneoplastic entity not be treated with an aggressive condylectomy that is required for treatment of neoplastic disease of the condyle. Instead, because the site of the aberrant cartilage responsible for condylar hyperplasia is located in the upper posterior portion of the condylar head just inferior to the articular surface, a high condylectomy is an adequate means of treating this entity. This high condylar shave, therefore, need only sacrifice approximately 5 mm of condylar head without fear for recurrence of the hyperplasia or the associated facial deformity.

When active condylar hyperplasia is occurring, the primary principle of treatment is that the pathologic condylar growth site be eliminated as soon as possible in order to mitigate the developing facial asymmetry. Further, it is desirable to achieve overall correction of the facial deformity with the fewest and least extensive surgical procedures possible. The ideal scenario is to perform the high condylar shave as well as the indicated orthognathic surgery with little or no presurgical orthodontics and to procure an occlusion that can be corrected by postsurgical orthodontics. For some individuals, however, this may not be possible. Such is the case when the facial deformity is such that significant preoperative orthodontics is necessary. This situation requires staged surgical procedures beginning with the condylar surgery. Once the presurgical orthodontic treatment has been completed, the second surgery addressing the asymmetric facial deformity may be performed.

Figure 7. Condylar hyperplasia of the right mandibular condyle. The patient displays a secondary pathologic asymmetry of the face, including a downward growth of her right mandibular body (A). Only mild occlusal disharmonies are present, including an ipsilateral posterior open bite (B). The preoperative panoramic radiograph (C) demonstrates a normally shaped right condyle, but with an elongated condylar neck.

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Figure 7 (Continued). The bone scans (D) show an active condylar hyperplasia with increased uptake in the right condyle. The surgery to correct this patient’s deformity required a high condylar shave and a reduction of the right inferior border of the mandible with decontamination and transposition of the right inferior alveolar neurovascular bundle (E,F).

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Epker and Fish\textsuperscript{4} have described three types of facial asymmetry that occur in association with condylar hyperplasia. The first, which is the most mild form of deformity, involves an ipsilateral posterior open bite with increased height of the ramus and body of the mandible. In such cases, orthognathic procedures are not necessary; however, unilateral reduction of the inferior body of the mandible is performed in conjunction with the high condylar shave of approximately 5 mm (Fig. 7). In performing the inferior border reduction, it is important to excise the excessive periosteum or tightly reapproximate it to the recontoured inferior border of the mandible. Failure to do this can result in some regrowth of the resected inferior border of the mandible by the osteocompeten: periosteum.

\textbf{Figure 7 (Continued).} At one year postoperatively, the patient shows favorable clinical (G) and radiographic (H) symmetry.
When the facial deformity is more severe owing to longer standing condylar hyperplasia, mandibular orthognathic surgery becomes necessary in addition to the inferior border resection and high condylar shave. This mandibular osteotomy effectively closes the ipsilateral open bite while correcting the mandibular occlusal cant and corrects any mandibular deviation that might exist. The most challenging scenario occurs when the facial deformity involves the maxilla. This requires multiple surgical corrections including high condylar shave, maxillary and mandibular osteotomies, and possible genioplasty and inferior border reduction.

Finally, condylar hyperplasia basically is a self-limiting pathologic process by virtue of its nonneoplastic character. As such, it produces excessive unilateral condylar growth and an associated facial asymmetric deformity for a period of time, and then ceases. With this in mind, the treatment for this condition changes when nuclear medicine scans fail to show increased uptake in the hyperplastic condyle. In particular, the need for a high condylectomy in these patients does not exist. Additionally, because the hyperplastic condition of the condyle is no longer active, the severity of the facial asymmetry does not become worse. There are, therefore, no time constraints placed on the presurgical orthodontics. Instead, the orthodontist may create nearly ideal dental alignment that then may be placed into proper relation with each other and with the patient's face by the indicated orthognathic surgery.

Benign Tumors

Although benign tumors of the mandibular condyle are rare, they may create significant facial asymmetric deformities. Perhaps the two most common benign tumors of this region are the osteochondroma and the osteoma. From a diagnostic standpoint, radiographic studies of a benign condylar tumor demonstrate a morphologically abnormally appearing condyle or tumor mass, or a tumor mass attached to an otherwise normal-appearing condyle. In general, however, and in distinction to condylar hyperplasia, the condylar neck is normal in length in cases of condylar tumors. Furthermore, there usually exists a considerable difference in the rate of excessive growth of a benign tumor of the condyle compared with condylar hyperplasia. In general, condylar hyperplasia grows more rapidly and tends to produce its associated dentofacial deformity more acutely. As such, this pathologic condition is more likely to be noted early and receive appropriate treatment before development of a more severe facial asymmetry. Conversely, a benign condylar tumor, most notably an osteochondroma, often develops slowly such that the facial deformity may be more severe before it is noted and treated.

The anatomy and location of most benign tumors of the condyle are such that an aggressive, complete condylectomy is necessary for cure (Fig. 8) compared with a high condylectomy that is used for treatment of condylar hyperplasia. At the same surgery the indicated orthognathic surgery may be performed, and reconstruction of the resected condyle is performed ideally with an autogenous costochondral graft.
Figure 8. An osteoma of the head of the left mandibular condyle. This benign tumor has created a secondary pathologic asymmetry consisting of deviation of the mandible to the contralateral side (A) with similar deviation of the occlusion (B). The conventional tomogram (C) displays the tumor emanating from the condylar head. The CT scans show the tumor displacing the left condyle out of its fossa (D), which is responsible for the contralateral deviation of the mandible.

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Figure 8 (Continued). This patient underwent a resection of the condyle/tumor mass (F) and immediate condylar reconstruction with a costochondral graft secured to the ramus with bicortical screws (F). The 1-year-postoperative facial view (G) shows normal symmetry of the face.
CONCLUSION

Various neoplastic and nonneoplastic pathologic processes may be responsible for primary and secondary facial asymmetries. Treatment is significantly different for each type of pathology and facial deformity, requiring that an accurate diagnosis be established by the surgeon.

References


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