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A Geometric Classification of Jaw Deformities

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Abstract

In the United States, the most widely used classification system for jaw deformities is the one provided by the International Classification of Diseases, Clinical Modification (ICD-CM), a taxonomy scheme that is based on the World Health Organization's International Classification of Diseases (ICD).

The last iteration of ICD-CM, version 10, sorts jaw deformities according to geometry, into 3 groups: anomalies of jaw size, anomalies of jaw-cranial base relationship, or unspecified. Yet these deformities can affect 6 different geometric attributes: size, position, orientation, shape, symmetry, and completeness.

In clinical practice and in teaching we have found the ICD-CM classification to be incomplete and disjointed. With this in mind, we have developed a better classification system. The purpose of this paper is to present it.

Introduction

In the United States, the most widely used classification system for jaw deformities is the one provided by the Center for Medicare and Medicaid Services and the National Center for

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Health Statistics. This classification is part of the International Classification of Diseases, Clinical Modification (ICD-CM), a taxonomy scheme that is based on the World Health Organization's International Classification of Diseases (ICD), the world's standard diagnostic tool for epidemiology, health management, and clinical care.¹

The last iteration of ICD-CM, version 10, sorts jaw deformities according to geometry, into 3 groups: anomalies of jaw size, anomalies of jaw-cranial base relationship, or unspecified (Table 1)². Yet these deformities can affect 6 different geometric attributes: size, position, orientation, shape, symmetry, and completeness.

In clinical practice and in teaching we have found the ICD-CM classification to be incomplete and disjointed. With this in mind, we have developed a better classification system. The purpose of this paper is to present it.

Problems of ICD-10-CM

The ICD-CM-10 classification scheme (Table 1) is superficial and misclassifies craniofacial jaw deformities. The classification system acknowledges only 2 types of jaw deformities, 1) *deformities of size* and 2) *deformities of jaw-cranial base relationship*. It lumps all other jaw deformities which are equally significant, as “*other*.”² An example of misclassification is listed under the heading: *anomaly of jaw-cranial base relationship*. This classification contains 4 sub titles: 1) *unspecified*, 2) *maxillary asymmetry*, 3) *other jaw asymmetry*, and 4) *other specified*.² The first one (unspecified) and last one (other specified) are generic bins that group different types of deformities, without distinction to geometric class. The two in the middle, *maxillary asymmetry* and *other jaw asymmetry*, don't belong in this category. Also the item “other jaw asymmetry” substituting for the logical next item *mandibular asymmetry* is bewildering.

Another example of misclassification is the exclusion of two conditions that one would expect to see in the category, i.e. prognathism and retrognathism.

The definition of deformity is having an abnormal form, disfigurement, or loss of the natural arrangement.³ To diagnose a deformity, we assess an anatomical unit and determine if its configuration (form) is normal or abnormal. Instead of the ICD-CM-10 system, the modern approach to the evaluation of form sees an anatomical unit (e.g., the mandible) as a geometric object.⁴ As any other geometric object, an anatomic unit is seen as having 5 basic attributes: size, position, orientation, shape, and completeness.

Size refers to how large or how small something is. Position refers to its location in space. Orientation refers to tilt. Shape to figure. Finally, completeness refers to the wholeness. Besides having these attributes, some anatomical units, such as jaws, also have bilateral symmetry. This means that the objects can be divided into 2 halves, each part being the mirror image of the other. In summary, the jaws have 6 geometric attributes, which include the 5 basic plus symmetry.

Geometric Classification of Jaw Deformities

Our classification scheme is presented as a mind map (Figure 1). The scheme first classifies jaw deformities as either osseous or dental. Osseous deformities affect the jawbones, while dental deformities affect the teeth.

The classification recognizes the jawbones as having 6 geometric attributes. They are: size, position, orientation, shape, symmetry, and completeness. Jaw deformities are classified according to the attribute they affect. Deformities of size occur when a jaw is too big or too small. The term *hyperplasia* indicates pathological enlargement, and *hypoplasia* failure to attain normal size. *Micrognathia* is a synonym for mandibular hypoplasia and *macrognathia* for mandibular hyperplasia. The terms *macrogenia* and *microgenia* also refer to size, macrogenia indicating large chin and microgenia a small one.

Abnormal jaw positions occur in all cardinal directions. *Prognathism* and *retrognathism* are deformities characterized by an abnormal anteroposterior position. By convention, the anteroposterior position is assessed in relation to the cranial base. In prognathism a jaw is too far forward, while in retrognathism it is too far back. In the transverse direction, a jaw can be displaced away from the sagittal plane in either direction. This deformity is called *laterognathia*. Vertically, a jaw can be too far down or too far up. In *excessive downward displacement*, a jaw is too far down. In *insufficient downward displacement*, it is too far up.

Malrotations occur when a jaw is abnormally oriented. We classify malrotations according to the axis on which the abnormal rotation occurs. A jaw that is abnormally rotated around the transverse facial axis has a *pitch-malrotation*. A jaw that is abnormally rotated around the anteroposterior axis has a *roll-malrotation*, a condition that is also known as canting. A maxilla or a mandible that is abnormally rotated around the vertical axis has a *yaw-malrotation*.

Shape refers to figure. A jaw with abnormal figure is said to be distorted.

The human face has reflection symmetry around one plane, the sagittal. For facial symmetry to exist, two conditions must be met. First, each of the units that compose the face must itself be symmetrical—a condition called object symmetry. Second, each of the units must be symmetrically aligned to the sagittal plane—a condition called symmetric alignment. Jaws can have deformities of symmetry either because of object-asymmetry or because of misalignment. The terms *mandibular asymmetry* and *maxillary asymmetry* refer to abnormalities in object symmetry. The term *asymmetric alignment* denotes abnormal alignment that causes asymmetry.

The term completeness refers the wholeness of the jaw. A jaw can be incomplete because one of its processes (apophysis) never developed. An example is agenesis of the condylar process of the mandible seen in hemifacial-microsomia. It can also be incomplete because some of its embryologic processes failed to fuse (cleft), or because it acquired a defect.

Frequently, the different jaw deformities (size, position, orientation, shape, and symmetry) are related. For example, asymmetric alignment does not occur in the absence of at least one other deformity. They include: laterognathia, abnormal roll, or abnormal yaw.

As stated above, jaw deformities can also affect the teeth. Like the ICD-CM², our classification scheme only considers dental deformities that engender malocclusion. Malocclusion can result when one or more teeth are disarranged in their dental arch. Alternatively, it can result when the upper and lower dental arches are not coordinated (Figure 1).

Within a dental arch, a deformity may affect the alignment, the leveling, or the spacing of teeth. Alignment refers to the arrangement of teeth in an arch. In ideal alignment, the incisal edges of the incisors and the buccal-cuspal-ridges of the canines, premolars and molars form an arch. Misalignment can happen because of dental displacement, dental tipping, or dental rotations. In *displacement*, a tooth is moved outside the arch. In *tipping*, a tooth is abnormally inclined. In *rotations*, a tooth is misaligned because of abnormal rotation around its long axis.

Leveling refers to the vertical arrangement of teeth. Abnormal leveling can affect a single tooth or the whole arch. For this assessment, one measures the vertical position of the teeth in relation to their occlusal plane. In other words, one measures the vertical positions of the lower teeth in relation to the mandibular occlusal plane and the vertical positions of the upper teeth in relation to the maxillary occlusal plane.

An individual tooth is in *infraocclusion* or *supraocclusion* when it is located below or above its ascribed occlusal plane. For a whole dental arch, one judges dental leveling by gauging the curve of Spee. From the central incisor backward to the last molar, the cusps of all teeth should inscribe either a flat plane or a curved-plane with slightly upward concavity. Dental deformity can create a *deep* or a *reverse* curve of Spee. A curve of Spee is *deep* when the cusps of the teeth trace a plane with a sharp upward curvature. The curve of Spee is *reversed* when the curvature of the plane has downward concavity.

Within a dental arch, the teeth should be normally spaced: adjacent teeth should touch without crowding each other. Spacing is abnormal when diastemas are present or when the arch cannot accommodate the teeth. The first condition is *excessive dental spacing* and the second *dental crowding*.

As stated above, dental deformities can also occur when the upper and lower arches are not harmonized. For normal occlusion to occur it is not enough for the upper and lower teeth to be normally arranged in an arch. The upper and lower dental arches must also be coordinated, in position, in shape, and in tooth size.

Discordant dental arch positions cause malocclusion. This lack of concordance can occur in all the cardinal directions: anteroposterior, vertical, and transverse. We appraise the anteroposterior occlusal relationships at three different sites. These are at the first molar, canine, and central incisors. In this appraisal, the frame of reference is the upper dentition.

That is, the examiner judges the anteroposterior position of the lower teeth in relation to hypothetical static upper.

Angle's molar relationship assesses the position of the buccal groove of the lower first molar in relation to the mesiobuccal cusp of the upper.⁵ A similar assessment is done in the canine region. Finally, in the incisal region, we measure the overjet. Based on these assessments, one classifies the occlusion into *neutroclusion*, *distocclusion*, or *mesiocclusion*. In neutroclusion, the molar and canine relationships are Class I, and the overjet is normal. In distocclusion, the molar and canine relationships are Class II and the overjet is either greater than normal (Division 1) or normal (Division 2). In mesiocclusion, the molar and canine relationships are Class III and the overjet is smaller than normal, usually negative.

Position discordance between the upper and lower dental arches also occurs in the vertical direction. Absence of vertical overlap between the upper and lower teeth produces an *open bite*. It can be can *anterior* or *posterior*. Excessive vertical-overlap of the anterior teeth results in deep bite. Excessive vertical-overlap of the posterior teeth results in *posterior bite collapse*. The last condition can only occur when posterior teeth are missing, and the remaining teeth have no opposing occlusion.

Finally, discordance between the maxillary and mandibular dental arches can also occur in the transverse dimension. Normally, the buccal cusps of the maxillary posterior teeth lay laterally to the buccal cusps of the mandibular teeth. When the reverse occurs, we encounter a *posterior crossbite*. In extreme cases, all the lower teeth can be inside the upper, a condition known as *Brodie bite*. Reversely, the upper teeth can be inside the lower, is condition known as *scissor bite*.

As mentioned before, the upper and lower arches can also occlude abnormally because they have different shapes. For example, a “U” shaped lower arch does not fit a “V” shaped upper. The lack of shape congruency between the upper and lower teeth results in *arch shape-discordance*.

Finally, to get good dental interdigitation in Class I occlusion, the width (mesio-distal size) of the lower teeth must be proportional to the width of the upper teeth.⁶ When this proportionality is absent, the dental arches have a *tooth size discrepancy*.

Discussion

In this paper, we present a new classification scheme for jaw deformities. The new system follows the modern morphometric approach of considering biological forms as geometric objects.⁴ It expands the grouping currently present in the ICD-CM system, from 2 specified deformities, to 6. It also provides a clear nomenclature for the whole category and for each individual type of deformity (Table 2).

Regarding terminology, we have made the following changes. First, we replace the nebulous term *dentofacial* with the precise and simpler term *jaw*. Dentofacial is a compound word made by the fusion of 2 words *dental* (dento-) and *face* (– facial), meaning: *of the teeth and face*. Based on the literal meaning of the term, one may assume that it embodies all the

deformities that affect the teeth and the face. In practice, however, this is not the case. The term is only applied to jaw deformities. Why then not use the simpler and more accurate term jaw deformities.

Second, we replace the terms: *vertical-maxillary-excess* and *vertical-maxillary-deficiency*. The terms *excess* and *deficiency* denote size; yet clinically, one establishes vertical “excess” or vertical “deficiency” by measuring the distance between the central incisors and the lip. Clearly, this metric measures position, not size. Thus to avoid confusion, we created new terms: *excessive downward displacement* and *insufficient downward displacement*, which harmonize with geometry.

We also adopted the term for *malrotation* for deformities of orientation. *Roll-malrotation* is substituted for *cant*⁷, *canting*^{8,9}, *occlusal-cant*¹⁰, and *maxillary cant*¹¹. *Yaw malrotation*, is substituted for *yaw*¹². And *pitch-malrotation* is substituted for terms like steep occlusal plane¹³, flat occlusal plane¹⁴, and *steep mandible*¹⁵. Roll and yaw malrotations can be *right* or *left*. In roll, right or left tell us the side where teeth are lower. Like an airplane that is rolling to the right will have its right wing down. For yaw, right or left specify where maxilla is pointing—when the pointer of its anteroposterior axis is towards the incisors. Pitch malrotation can be *excessive* or *insufficient*. In excessive pitch malrotation the inclination of the jaws is steep. In insufficient pitch malrotation, the inclination is shallow, flat or reversed.

Our final alteration of the current terminology is to use distinctive terms to distinguish between the 2 different types of asymmetry: plain *asymmetry* which refers to object (intrinsic) asymmetry and the qualified term *asymmetric alignment*, which refers to jaw misalignment in relation to the sagittal plane of the face.

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FIGURE 1.

Jaw deformities.

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Table 1

ICD-10-CM Classification of Jaw Deformities

M00-M99 Diseases of the Musculoskeletal System
M26-M27 Dentofacial anomalies [including malocclusion] and other disorders of jaw
M26 Dentofacial anomalies [included malocclusion]
M26.0 Major anomalies of jaw size
M26.00 Unspecified anomaly
M26.01 Mandibular Maxillary hyperplasia
M26.02 Maxillary hypoplasia
M26.03 Mandibular hyperplasia
M26.04 Mandibular hypoplasia
M26.05 Macrogenia
M26.06 Microgenia
M26.07 Excessive tuberosity of jaw
M26.09 Other specified anomalies of jaw size
M26.1 Anomalies of jaw-cranial base relationship
M26.10 Unspecified anomaly of jaw-cranial base relationship
M26.11 Maxillary asymmetry
M26.12 Other jaw asymmetry
M26.19 Other specified anomalies of jaw size
M26.2 Anomalies of dental arch relationship
M26.20 Unspecified anomaly of dental arch relationship
M26.21 Malocclusion, Angle's class
M26.22 Open occlusal relationship
M26.220 Open anterior occlusal relationship
M26.220 Open anterior occlusal relationship
M26.221 Open posterior occlusal relationship
M26.23 Excessive Horizontal Overlap
M26.24 Reverse Articulation
M26.24. Anomalies of interarch distance
M26.29 Other anomalies of dental arch relationship
M26.3 Anomalies of tooth position of fully erupted tooth or teeth
M26.30 Unspecified anomaly of tooth position of fully erupted tooth or teeth
M26.31 Crowding of fully erupted teeth
M26.32 Excessive spacing of fully erupted teeth
M26.32 Horizontal displacement of fully erupted tooth or teeth
M26.34 Vertical displacement of fully erupted tooth or teeth
M26.35 Rotation of fully erupted tooth or teeth
M26.36 Insufficient interocclusal distance of fully erupted teeth (ridge)
M26.37 Excessive interocclusal distance of fully erupted teeth
M26.39 Other anomalies of tooth position of fully erupted tooth or teeth
M26.4 Malocclusion, unspecified

Table 2

Jaw Deformity Nomenclature

Attribute	Aspect	Names
Size	Too big	Hyperplasia, macrognathia, macrogenia
	Too small	Hypoplasia, micrognathia, microgenia
Position	Anteroposterior	Prognathism, retrognathism
	Transverse	Laterognathia
	Vertical	Excessive downward displacement, insufficient downward displacement
Orientation		Malrotation
Shape		Distortion
Completeness		Agenesis, cleft, defect
Symmetry	Object	Asymmetry
	Alignment	Asymmetric alignment