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RESEARCH ARTICLE

FACIAL ASYMMETRY: CLASSIFICATIONS THROUGH THE AGES

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ABSTRACT

Francis Galton, once asked "What's in a face?"His main aim was to understand if there was a similar facial appearance for both. To do this, he made photographic composite images of both faces, he overlaid numerous images of faces onto a single plat creating one final composite face that had characteristics of each original face. He noticed that the composite face was much more attractive than the original faces. "This phenomenon is now known as the averageness effect, where attractive faces tend to be indicative of the average traits of the population. There are two main explanations (that follow the symmetric theory) that explain the attractiveness of the composite face. The evolutionary advantage theory proposes that individuals with symmetric faces tend to be more attractive. It draws upon the fact that they look healthier than those with unsymmetrical faces. Human genes are created to develop symmetrically. Asymmetric faces are formed from defects and small imperfections created before and after birth. Most of the people have slight facial asymmetry which in normal but some people have significant asymmetrical faces. Various etilogical factors contribute to facial asymmetry. It has a wide range of possibilities because of structures involved, structures in question and causative factors. Understanding the etiopathology and classifications of facial asymmetry helps for accurate diagnosis and treatment planning. Various authors have classified facial asymmetry on the bases of etiology or morphology, time of onset, structures involved, whereas some have described facial asymmetry on merely facial measurements. The sole purpose of this article is to provide all the classifications of facial asymmetry by various authors.

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INTRODUCTION

The symmetry of the face is one of the most important features for the perception of attractiveness of any person. The word "symmetry" derives from Greek and comes from "syn" (together) and "metron" (meter). Symmetry means that both sides of the face, right and left, are alike.[1] Stedman's Medical Dictionary defines symmetry as "equality or correspondence in the form of parts distributed around a center or an axis, at the two extremes or poles, or on the two opposite sides of the body.[2] Most people have some slight facial asymmetry, and this is the normal biological situation in humans; i.e., the two sides are not perfect mirror images. When photographs of the face are compared with photographs consisting of two left or two right sides of the face, we observe three different faces. This is called natural subclinical asymmetry and is a normal situation. The degree of asymmetry has a negative impact on functional and facial aesthetics. Anthropological research has shown that symmetry and averageness are important keys to the attractiveness of human faces. The concept of facial symmetry is very significant to attractiveness. The problem of facial asymmetry is complex and has a wide range of possible causes. Analysis of facial features is useful for dentists, surgeons, orthodontists, and aesthetic medicine specialists. The causes of facial asymmetry are significant, especially from the orthodontic and dental points of view.

Facial asymmetries are most commonly classified according to aetiology or morphology. Other classifications are based on time of onset, structures involved, and surgical planning outcomes and may even be restricted to the mandible alone.[3]

CLASSIFICATIONS: Various authors have classified facial asymmetry:

1961, Lundstrom [4]

A. Classification of asymmetries

- **Fundamental (heart)**
- **Varying**
  - **Qualitative**
    - Normal (hairwhorl)
    - Anomalies (unilateral absence of teeth)
  - **Quantitative**
    - Normal variation
      - Symmetric type (tooth diameter)
      - Asymmetric type (arm- length)
    - Anomalies (giant tooth)

B. From orthodontic aspect

- Qualitative asymmetry
  - Number of teeth
  - Cleft palate
- Quantitative asymmetry
  - Size of teeth
  - Location of teeth in the dental arches
    - Anteroposterior position
    - Lateral position
    - Vertical position
  - Location of dental arches in the head
    - Rotation in the horizontal plane
    - Rotation in the frontal plane
    - Lateral translation

1974, Plint [5]

- **True asymmetries**
  - Malformations
  - Non-pathological true asymmetry
- **Apparent facial asymmetry**

- **True asymmetries**
  - **Malformations:** Skeletal malformations -plagiocephaly, first arch defects and unilateral clefts of the hard palate and alveolus. Soft tissue malformations - neurofibromatosis and haematomas, especially cystic hygromas.
  - **Non-pathological true asymmetry:** Asymmetry in the middle third of the face: reveals no displacement of the chin point or the lower incisor centre line. Asymmetry in the middle third of the face: reveals facial discrepancy.
- **Apparent Facial asymmetry:** The hard and soft tissues fall within the "normal" range of variation, and the asymmetry is due to an eccentric position of the mandible arising from a displacement caused by occlusal anomalies.
  - Skeletal antero-posterior discrepancies (e.g. Class Ill cases with bites of accommodation).
  - Skeletal transverse discrepancies with narrowness of the maxilla (e.g. so-called adenoidal facies).
  - Maxillary narrowness associated with atypical soft tissue behaviour (e.g. thumb sucking and atypical swallowing).
  - Local factors (e.g. one or more teeth in crossbite or malpositioned, leading to displacement).

1986, Obwegeser [6]

A. Hemimandibular hyperplasia: It always exhibits the same typical presentation. This depends on the one hand upon the age of the patient during the initial stage of the abnormal growth, on the degree of the abnormal growth and upon the duration of the abnormal growth of the mandible. Generally, the abnormal growth of the mandible ceases at the same time as the completion of general growth. It can also keep on growing beyond this point to produce grotesque pictures.

- Typical Hemimandibular hyperplasia
- Diagnostic characteristics of hemimandibular hyperplasia

B. Hemimandibular elongation: is characterized by horizontal displacement of the mandible plus chin towards the unaffected side.
- Slender form of hemimandibular elongation
- Non-slender form of hemimandibular elongation
- Bilateral hemimandibular elongation
- Differential diagnosis

C. Combined & hybrid forms: variability can occur in association with the various forms of normal mandibles of the opposite side, or even a micromandible on one side might exist – this happens mostly in the case of hypoplasia of the condyle and one of the two described hemimandibular anomalies on the other side, in either pure or hybrid form.

- Bilateral combination forms
- Unilateral hybrid forms

1994, Pirttiniemi [7]

Mandibulofacial asymmetry originating during the prenatal period

- Embryonal period: Approximately 1% of all newborn infants have multiple anomalies or birth defects, 40% of which can be diagnosed as representing a specific, recognized syndrome.
  - Hemifacial microsomia
  - Congenital hemifacial hypertrophy
- Fetal period: About 2% of newborn infants have deformations that are thought to be caused by nondisruptive mechanical forces during the period of intrauterine life after organogenesis, at a time when the fetus is prone to deformations because of its great plasticity and rapid growth.
- Congenital muscular torticollis
- Postural scoliosis patients
- Plagiocephaly

Mandibulofacial asymmetry with predominantly postnatal expression :

- **Unilateral overgrowth of mandible**: Unilateral overgrowth of the mandibular condyle can distort the growth of the whole mandible in a variety of ways. It may occur as an enlargement of the whole half of the mandible, with associated prognathism, and as a unilateral overgrowth of the condyle or condylar neck with or without prognathism.
- **Progressive hemifacial atrophy:** Hemifacial atrophy, the most common form of which is known as the Romberg syndrome, is characterized by slowly progressing atrophy that primarily involves the subcutaneous tissues, fat, and bone.
- **Infections and inflammation:** Infectious diseases mostly originating from middle ear infections and leading in some cases to ankylosis of the temporomandibular joint, were earlier regarded as important etiologic factors in asymmetric mandibulo-facial development, but their role is diminishing, reflecting better medical care and the development of antimicrobial medication.
- **Fractures and trauma:** Condylar fractures may produce impaired growth and function, which may later lead to severe facial deformity.
- **Lateral malocclusion and mandibular deviation:** Lateral malocclusion in growing children is often associated with a lateral forced bite in which the mandible deviates laterally into the maximal intercuspal position during closure.

1994, Bishara [8]

- **Dental asymmetries:** These can be due to local factors such as early loss of deciduous teeth, congenitally missing tooth or teeth, and habits such as thumb sucking.
- **Skeletal asymmetries:** The deviation may involve one bone such as the maxilla or mandible, or it may involve several skeletal and muscular structures on one side of the face.
- **Muscular asymmetries:** Facial disproportions and midline discrepancies could be the result of muscular asymmetry, as might occur with hemifacial atrophy or cerebral palsy.
- **Functional asymmetries:** These can result from the mandible being deflected laterally or anteroposteriorly if occlusal interferences prevent proper intercuspation in centric relation.

1995, Cohen [9]

- **Hemihyperplasia:** Hemihyperplasia may affect either one tissue such as bone with secondary regional consequences or multiple tissues on a primary basis such as in "hemihypertrophy".
- **Hemihypoplasia:** Hemihypoplasia may affect one tissue such as bone with secondary regional consequences or multiple tissues on a primary basis, such as in hemifacial microsomia.

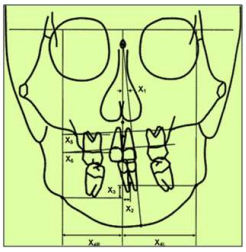
- **Hemiatrophy:** Facial changes usually begin during the first decade and spread slowly and progressively to involve soft tissue, muscle, cartilage, and underlying bone. There is a marked predilection for left-sided involvement.
- **Miscellaneous hemi-asymmetries:** The Bencze syndrome is an autosomal dominantly inherited condition characterized by facial asymmetry, esotropia, and amblyopia. Hemimaxillofacial dysplasia is a recently recognized disorder of facial asymmetry and unilateral maxillary alveolar enlargement associated with *hypoplastic* teeth.

2007, Hwang [10]

For the measurements related to facial asymmetry, 7 measurements were made from the frontal cephalograms and 1 measurement from the photographs.

- **Menton (Me) deviation (X1):** the angle formed by the crista galli-Me line and MSR.
- **Apical base midline discrepancy (X2):** horizontal distance between the midpoints of the maxillary central incisor roots and the mandibular central incisor roots.
- **Vertical difference of right and left antegonion (X3):** vertical distance between right antegonion (Ag) and left Ag.
- **Horizontal difference of right and left Ag (X4):** the difference between horizontal positions of the right Ag and left Ag.
- **Maxillary base canting (X5):** the angle formed by the line connecting the right and left jugal points and the horizontal reference line, which is vertical to MSR.
- **Maxillary alveolar canting (X6):** the angle formed by the line connecting the right and left points constructed with the buccal contour of the first molar and the adjacent alveolar bone contour and the horizontal reference line.
- **Bulkiness difference of mandibular inferior border (X7):** the difference between the right and left bulkiness of the mandible determined subjectively as a number from 1 to 5, with a larger number for more severe asymmetry.
- **Lip line canting (X8):** the angle formed by the line connecting the right and left commissures of the lip and the interpupillary line.

5 groups with different characteristics were classified based on 3 variables, whereas 8 variables were used. This indicates that facial asymmetry can be classified by using only 3 variables: Mx, maxillary apical base midline; Mn, mandibular apical base midline; Me, Me position. (Figure 1):



Variables	*Group A*	*Group B*	*Group C*	*Group D*	*Group E*
X1	Severe	Mild	Moderate	Moderate	NS
X2	Severe	Mild	Moderate	Mild	NS
X3	Superiorly	Inferiorly	NS	Superiorly	NS

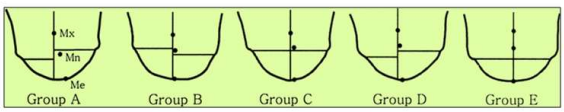


Figure 1. 5 groups by Hwang

2008, Haraguchi [11]

Conventional facial photos were used. The photos had been taken with the head fixed using ear rods and the Frankfort horizontal plane parallel with the ground in maximum intercuspation. Points *err* and *erl* were defined as points on the patient's right and left sides where a line connecting the centers of the ear rods intersects the outer contour of the face. The facial midline was defined as the perpendicular bisector of the line between the centers of the right and the left pupils (*p*). The differences in the distance between *err* to the facial midline and from *erl* to the facial midline were defined as dFW. Soft-tissue menton, *me*, was defined as the lowest point of the outer contour of the face on the standardized facial photographs. The horizontal distance between *me* and the facial midline was defined as dME. The key to evaluating facial asymmetry with any of these methods is defining the criteria for determining the facial midline. Because there is no absolute facial midline, the centers of the pupils of the eyes were employed as landmarks for defining the facial midline, as well as defined the area of the head forward of the ears as the face. Facial laterality was examined from two perspectives:

- Which side of the hemiface is most likely to be wider
- To which side does the chin tend to deviate.

In the skeletal Class I group, the proportion of subjects with no significant jaw deviation decreased with age, whereas the proportion of those with left-sided jaw deviation increased.

In the skeletal Class III group, the proportion of subjects without chin deviation also decreased throughout the pubertal growth period, and the proportions of both those with left-sided deviation and those with right-sided deviation tended to increase. In contrast, skeletal Class III patients generally exhibit greater growth and also may be more likely to be affected by postnatal, environmental influences because of the relatively longer jaw growth period.

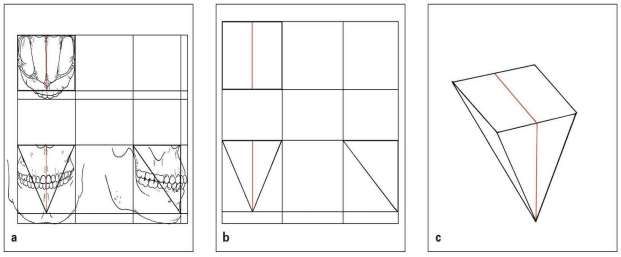


Figure 2: (a) Diagrammatic illustration of the three-dimensionality of the maxillomandibular complex. (b and c) Construction of a pyramid representing the maxillomandibular complex.

2008, Chia [12]

1 Developmental

- **Hemimandibular elongation-** it is a developmental deformity of unknown aetiology affecting the mandible unilaterally. It commonly presents with a progressively increasing transverse displacement of the chin point in young adulthood.
- **Hemimandibular hyperplasia-** It is a three-dimensional developmental enlargement of one side of the mandible including the condyle, condylar neck, ramus and body. It typically only affects one side of the mandible and the enlargement is characterized by abruptly stopping at the midline of the mandibular symphysis.
- **Hemifacial microsomia-** It is a congenital disorder that results in a deficiency in the hard and soft tissues on predominantly one side of the face. The condition is thought to be caused by a defect in the proliferation and migration of early embryonic neural crest cells, which results in defects of the 1st and 2nd branchial arch.
- **Achondroplasia**
- **Hemifacial hypertrophy-** it is a rare form of overgrowth that may cause asymmetry in the craniofacial structures, including soft and hard tissues. It may also affect the occlusion.
- **Torticollis**
- **Hemifacial atrophy (Parry-Romberg syndrome)-** It is a rare disorder that is characterized by progressive atrophy of underlying soft tissues and bones on one side of the face. Hemifacial atrophy is a disorder of uncertain aetiology.

Table 1. Classification by Wolford

CH	Age of onset	Clinical characteristics	Imaging
Type 1A	Pubertal growth	bilateral accelerated symmetric or asymmetric growth; self-limiting; can grow into mid-20s; Class III occlusion; prognathic mandible	elongated condylar head, neck, body; normal condylar head shape; MRI: thin discs; asymmetric cases may involve contralateral disc displacement
Type 1B	Pubertal growth	unilateral accelerated asymmetric growth; self-limiting; can grow into mid-20s; deviated mandibular prognathism; ipsilateral Class III occlusion; anterior and contralateral crossbite	unilateral elongated condylar head, neck, body; deviated prognathism; MRI: thin disc; may have ipsilateral/contralateral disc displacement
Type 2	Two-thirds of cases begin in the second decade	unilateral vertical elongation of face and jaws; not self-limiting; can grow indefinitely; ipsilateral posterior open bite	unilateral vertical enlarged condylar head, neck, ramus, body; MRI: ipsilateral disc commonly in place; contralateral TMJ arthritis, displaced disc, 75% of cases
Type 2A			vertical growth vector; no horizontal exophytic growth off condyle
Type 2B			enlargement of condyle with exophytic growth off the head
Type 3	unilateral facial enlargement	varies from normal anatomy of condyle; usually presenting as condylar enlargement	benign tumors, e.g., osteoma, neurofibroma, giant cell tumor, fibrous dysplasia, chondroma, chondroblastoma, arteriovenous malformation
Type 4	no specific age	unilateral facial enlargement	varies from normal anatomy of condyle; usually presenting as condylar enlargement with lytic lesions

2. Pathological

- **Tumours and cysts-** these may affect the soft tissues, salivary glands, nerves and bone. These are commonly asymmetric in presentation, being distinguished from developmental abnormalities by their clinical behavior and effects. The local effects result from compression, invasion, ulceration, or destruction of adjacent structures.
- **Infection-** Various infections can present asymmetrically. Examples of those that may cause mandibular asymmetry include dento-alveolar abscesses and acute parotitis. These are characterized by their rapidity of onset, pain, pyrexia, malaise and associated regional lymph node involvement.
- **Condylar resorption-** Several conditions may cause resorption of the mandibular condyles. These include juvenile rheumatoid arthritis, post-steroid therapy and orthognathic surgery.
- **Traumatic- condylar fractures -:** Trauma to the condylar region during childhood may result in growth arrest and impaired function. The majority of cases remain undiagnosed. If growth arrest does occur, this may produce a chin asymmetry towards the side of the affected condyle.
- **Functional- Mandibular displacement-** A buccal crossbite occurs when the buccal cusp of a mandibular molar occludes buccal to the buccal cusp of the corresponding maxillary tooth. Slight transverse narrowing of the maxilla or associated dentition may result in mandibular to maxillary cusp to cusp occlusal interferences, resulting in a lateral displacement of the mandible as the patient tries to achieve maximal intercuspation on closure.

2009, Wolford [13]

- **Pseudoasymmetry:** The mandible is postured asymmetrically toward one side with one condyle displaced forward relative to the centric relation position in the fossa.
  - Malocclusion
  - Muscle dysfunction (Dystonia)
  - Condylar dislocation
  - Infection
- **Developmental facial asymmetry:** Asymmetry is usually present at birth but may or may not be identified till later, depending upon the severity of the deformity.
- **Dentoalveolar asymmetry:** This can be a result of genetics, congenital or developmental deformity, trauma, pathology, growth variance, iatrogenic injury, and so on.
- **Overdevelopment:** Unilateral overdevelopments of the face can cause significant facial asymmetry.
  - Unilateral condylar hyperplasia
  - Mandibular condylar osteochondroma or osteoma
  - Muscle hypertrophy
  - Neuromuscular disorders
  - Tumor
- **Unilateral facial underdevelopment or degeneration:**
  - Trauma
  - Iatrogenic facial asymmetry
  - Temporomandibular joint ankylosis
  - Hemifacial microsomia
  - Unilateral adolescent internal condylar resorption
  - Unilateral reactive arthritis
  - Autoimmune and connective tissue diseases

2010 , Reyenke (figure 2): [14]

- Congenital
- Developmental
- Posttraumatic
- Pathology causes

2011, Cheong: [15]

- **Congenital**
  - Cleft lip and palate
  - Tessier craniofacial cleft
  - Hemifacial microsomia
  - Neurofibromatosis
  - Torticollis
  - Craniosynostosis
  - Vascular disorders
  - Others
- **Developmental- Cause unknown**
- **Acquired**
  - Temporomandibular joint ankylosis
  - Facial trauma
  - Childhood radiotherapy
  - Fibrous dysplasia
  - Other facial tumors
  - Unilateral condylar hyperplasia
  - Romberg's disease
  - Others

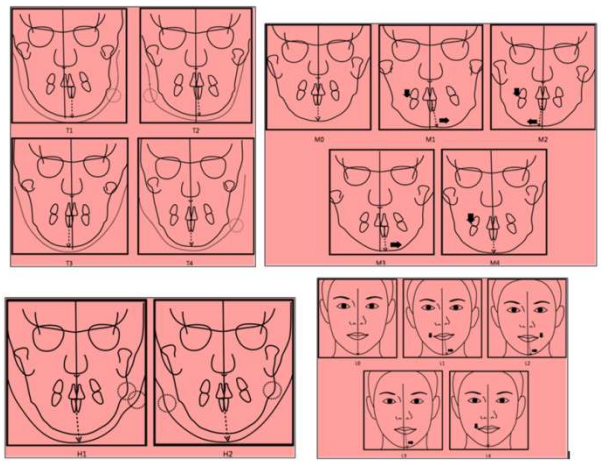


Figure 3. Classification by Kim

2012, Waite: [16]

- **Congenital anomalies:** These are conditions acquired during in-utero development and can be further subdivided into malformations, deformities, and disruptions. Malformations are the result of an intrinsically abnormal developmental process during embryogenesis.
    - Hemifacial microsomia
    - Cleft lip and cleft palate
    - Craniosynostosis: Plagiocephaly
    - Congenital hemifacial hyperplasia
- Developmental facial asymmetries: These are conditions arising during postuterine growth through adulthood.
    - Primary growth deformities
    - Facial Hemiatrophy
    - Hemimandibular hyperplasia
    - Secondary growth deformities
- Acquired facial asymmetries: These are clinical conditions arising from either traumatic injuries or pathologic lesions.
    - Condylar trauma
    - Juvenile Idiopathic Arthritis
    - Degenerative Joint Disease

2014, Wolford, (Table 1): [17]

- Condylar Hyperplasia type 1
    - CH type 1A
    - CH type 1B
- Condylar Hyperplasia type 2
    - CH type 2A
    - CH type 2B
- Condylar Hyperplasia type 3
- Condylar Hyperplasia type 4

2014, Kim (Figure 3): [18]

Combination of menton deviation and transverse asymmetry (T-group):

- **T1:** Equal direction of menton deviation and transverse soft tissue asymmetry
- **T2:** Opposite direction of menton deviation and transverse soft tissue asymmetry
- **T3:** Absence of transverse asymmetry despite the presence of menton deviation
- **T4:** Presence of transverse asymmetry without menton deviation
- Sub-classification of transverse asymmetry according to the direction of angle prominence in soft
- vs. hard tissue :
- **H1:** Equal direction of transverse asymmetry in soft vs. hard tissue
- **H2:** Opposite direction of transverse asymmetry in soft vs. hard tissue

Combination of deviation of menton and cant in soft and hard tissue

Classification in hard tissue

- **M0:** Neither maxillary cant nor menton deviation
- **M1:** Presence of menton deviation and maxillary cant with mental deviation and
- downward maxillary cant in opposite directions
- **M2:** Presence of menton deviation and maxillary cant with equal direction of mental
- deviation and downward maxillary cant
- **M3:** Presence of menton deviation without maxillary cant
- **M4:** Presence of maxillary cant without menton deviation

Classification in soft tissue:

- **L0:** Neither lip canting nor soft tissue menton deviation
- **L1:** Presence of soft tissue menton deviation and lip cant with mental deviation and
- downward maxillary cant in opposite directions
- **L2:** Presence of soft tissue menton deviation and lip cant with equal direction of
- mental deviation and downward of maxillary cant
- **L3:** Presence of soft tissue menton deviation without lip canting
- **L4:** Presence of lip canting without soft tissue menton deviation

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