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Morphological and Radiological Variations of Mandibular Condyles in Health and Diseases: A Systematic Review

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Abstract

The appearance of mandibular condyle varies greatly among different age groups and individuals. Human mandibular condyles may be categorized into five basic types: flattened, convex, angled, rounded and concave. Morphologic changes of condyle occur due to developmental variations, remodeling, various diseases, trauma, endocrine disturbances and radiation therapy. Genetic, acquired, functional factors, age groups, individuals have a role in morphologic changes in shapes and sizes of condyle. Thus variability in the shapes and sizes of condyles should be an important factor in diagnosing the disorders of temporomandibular joint. Differentiating diseased conditions from anatomical variations of the condylar head possess a diagnostic challenge for the radiologist and surgeons on numerous occasions. The purpose of this review is to describe in detail about normal anatomical and morphological variations in condylar head, thus helping an investigator to distinguish between variations in form and pathologic condition.

Keywords: Condyle; Mandible; Temporomandibular joint; Developmental disorders

Introduction

One of the most important and unique joints in the body is the Temporomandibular Joint (TMJ). TMJ is a freely movable articulation between the condyle of the mandible and squamous portion of the temporal bone at the base of the skull [1]. The function and health of TMJ is vital to life. The functions of the temporomandibular joint, is to provide smooth, efficient movement of the mandible during mastication, swallowing and speech and to provide stability of mandibular position and prevent dislocation from external or unusual forces. The condyle is very special because expression of the mandibular growth is provided by mandibular condyle [2].

The appearance of the mandibular condyle varies greatly among different age groups and individuals. Morphologic changes may occur on the basis of simple developmental variability as well as remodeling of condyle to accommodate developmental variations, malocclusion, trauma and other developmental abnormalities and diseases [3,4]. A thorough understanding of the anatomy and morphology of the TMJ is essential so that a normal variant is distinguished from an abnormal condition. The current review focuses on various shapes and sizes of mandibular condyle in health and diseases.

Methodology

A search of literature available in MEDLINE and SCIENCE DIRECT databases from the year 1961 to 2011 was conducted using keywords morphology of mandibular condyle, size and shapes of mandibular condyle, developmental defects of condyle and disorders of mandibular condyle.

Morphology of Mandibular Condyle

Mandibular condyle varies considerably both in size and shape. When viewed from above, the condyle is roughly ovoid in outline. It is 15 to 20 mm side to side and 8 to 10 mm from front to back [3]. There is great variation in the size and shape of the components of the temporomandibular joint, and its relationship to each other. It is often assumed that the normal condylar head must have a convex configuration throughout and that symmetry should exist between contralateral sides in the same individual. Several studies have attempted to evaluate the morphology of the human condyles [2]. Variation in the human mandibular condyle shapes was noted by previous researchers [2]. A normal variation of the condylar morphology occurs with age, gender, facial type, occlusal force, functional load, malocclusion type and between right and left sides. The most prevalent morphologic changes are detected in the TMJ of elderly persons due to the onset of joint degeneration.TMJ morphology has been studied on dry and autopsy human skulls, histology, radiographic exams, magnetic resonance, computed tomography and Cone-Beam Computed Tomography (CBCT) methods [5].

In 1960s and 1970s studies were performed mainly on dry skulls and autopsy materials [6-8]. These studies used macroscopic observations, radiological cephalometry and tomography. In 1961, Yale et al. was the first one to report about the different shapes of mandibular condyle [6]. Initially Yale classified condylar head based on superior view into three categories namely concave, convex and flat, however later on he simplified it into four categories namely convex, flattened, angled and rounded [6,7,9] (Figure 1).

A study in 1980's on mandibular condyle morphology in relation to malocclusion in children revealed that the condylar size in males was greater than in females and midline discrepancy significantly altered the increase in condylar size during growth [10].

By using high resolution CT images condyle morphology was classified as flat, round, convex, concave and angled. Convex type was observed very frequently followed by angled, concave and round. In women convex type was observed predominantly, whereas in men concave type [11].

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Figure 1: Shapes of condyle [9].
Type A- superior surface flattened, Type B- superior surface convex, Type C - superior surface angled and Type D- superior surface rounded.

Using different radiographic techniques many studies were done to detect the condylar morphology, to compare the accuracy of detecting condylar changes in temporomandibular disorders. Previous studies regarding the morphology of condyle have shown that shape variability of the condyle was mainly related to inclination of the condylar head, shape variability of the fossa was related to inclination of the eminence and fossa height [12]. Major change in condylar size during growth was noticed in mediolateral dimension than antero-posterior [10].

Evaluation of shape of the condyles upon surgical exposure of TMJ revealed that most condyles had a normal size and shape. Other varieties like excavated form, oblique shape, small round condyles and flattened condyles were also noted [13] (Figure 2).

Imaging Techniques

Prior to 1990's studies were done with plain films later by using CT, MRI techniques. Studies have shown that Tomograms play a valuable role in patients with temporomandibular disorders [14,15]. Various comparative studies of different techniques to evaluate morphology of condyles were done. Plain film radiography is useful as a screening modality for TMJ abnormalities. It is valuable for determining the presence of osseous changes [16-21]. CT provides information concerning bone assessment [16-23]. Biplanar tomography provides more accurate assessment of condylar lesions than biplanar panoramic images [24]. Conventional tomography is superior to midfield magnetic resonance imaging for assessment of osseous changes of the temporomandibular joint [25]. CBCT images are superior over others for the bony morphology of mandibular condyles and detection of condylar cortical erosion [26-28]. CBCT is a useful tool to measure and evaluate the condylar dimensions [5]. MRI has become the examination choice in evaluating TMJ soft tissue changes [16-18,20,21,29].

Radionuclide bone scanning is a useful technique for showing early functional and biochemical bone changes. It is much more sensitive than plain radiography at detecting areas of demineralization but it is non-specific so an increased area of uptake may result from infection, inflammation, neoplasia or any other cause of active bone turnover. Bone scanning using technetium labeled Methylene diphosphonate can also be used to show active condyle growth and so this technique has been used in the assessment of patients who present with suspected condylar hyperplasia [21].

Panoramic radiographs are not a reliable method for accurately judging the shape of the mandibular condyle [30] and it was noted that Sonography is an insufficient imaging technique for the detection of condylar changes [31].

Sizes and Shapes of Condyle in Various Conditions

We have enlisted numerous conditions causing alterations in shapes and size of mandibular condyle as follows

1. Developmental defects

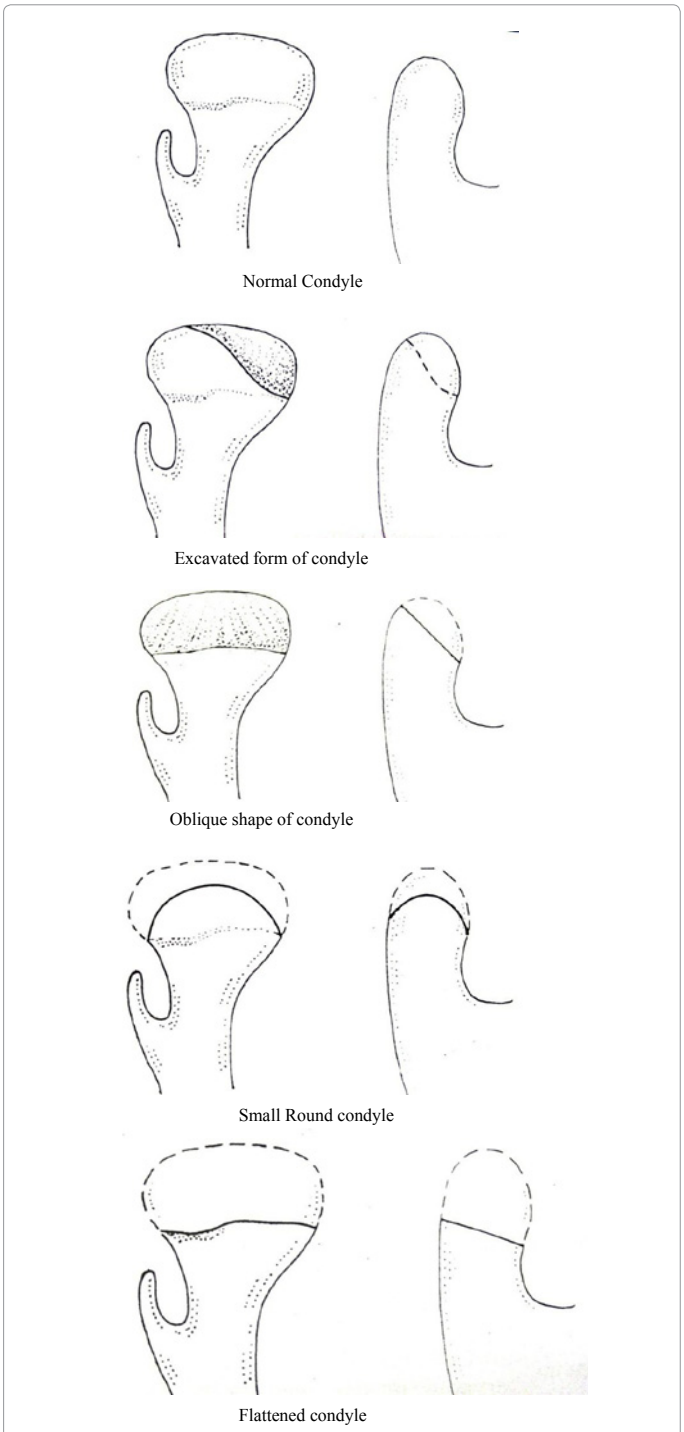

Figure 2: Shapes of condyle on surgical exposure [13].

- Condylar hyperplasia
- Condylar hypoplasia
- Agenesis
- Bifid condyle

2. Syndromes

- Hemifacial Microsomia
- Treacher Collins Syndrome
- Hallermann-Steiff Syndrome
- Pierre Robin Syndrome
- Oculo mandibulo dyscephaly
- Progeria

3. Degenerative joint disease
4. Inflammatory / infectious diseases

- Rheumatoid Arthitis
- Psoriatic Arthitis
- Septic Arthitis

5. Cysts of TMJ

- Aneurysmal Bone Cyst
- Simple bone cyst
- Ganglion cysts and synovial cysts

6. Tumours of the TMJ

- Osteoma
- Osteochondroma
- Chondroblastoma
- Osteosarcoma
- Ewing's sarcoma

7. Metabolic Disease

- Gout

8. Endocrine Disturbances

- Gigantism and Acromegaly
- Hypothyroidism and Hypopituitarism

9. Trauma
10. Radiation

Developmental disturbances involving the TMJ may result in anomalies in the size and shape of the condyle. Hyperplasia, hypoplasia, agenesis, and formation of a bifid condyle may be evident on radiographic examination of the joint. Local factors, such as trauma or infection, can initiate condylar growth disturbances [32].

Condylar hyperplasia is created by excessive growth of the condyles where irregular enlargement of the condylar neck is observed radiographically. In condylar hypoplasia, condyle may be absent in severe cases and in milder types condylar process will be short and condylar head will be poorly formed [32]. Condylar hypoplasia can be either congenital or acquired. Congenital condylar hypoplasia often is associated with head and neck syndromes (Figure 3). In the most severe cases there is complete agenesis of the condyle or ramus (condylar aplasia). Acquired condylar hypoplasia results from disturbances of the growth center of the developing condyle. Condylar hypoplasia can be either unilateral or bilateral. Few authors have reported about aplasia of the mandibular condyle without any syndrome, family history or any history of trauma [33].

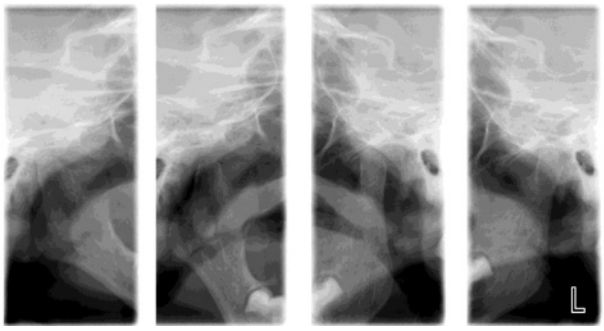

Figure 3: TMJ (open and close) view illustrates the condylar aplasia of the right side.

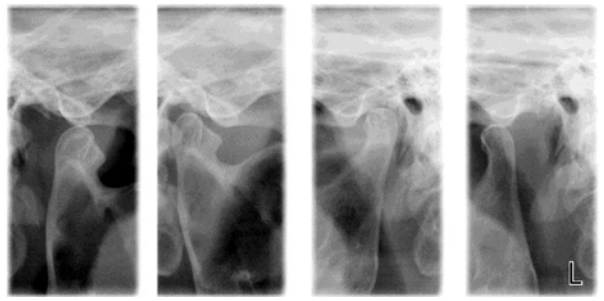

Figure 4: TMJ (open and close) View Showing Bifid Condyle on right side.

In Bifid condyle, condylar head is bilobed (Figure 4). Most bifid condyles have a medial and lateral head divided by an anteroposterior groove. Some condyles may be divided into an anterior and posterior head [34,35]. In the available literature unilateral bifid condyle have been reported more often when compared to bilateral bifid condyle [34-38].

Many syndromes results in a variety of abnormalities of the face and jaws, including abnormalities of structure, shape, organization and function of hard and soft tissues. The term syndrome is defined as the aggregate of signs and symptoms associated with any morbid process that together constitute the picture of the disease [39]. Hypoplasia of the mandibular condyle is seen in Hemifacial Microsomia, Treacher Collins Syndrome, Hallermann-Steiff Syndrome [40-50]. Aplasia of mandibular condyles noted in Hemifacial Microsomia and Oculo mandibulo dyscephally [40-47].

Other than developmental anomalies, condylar shapes and sizes varies in conditions like cysts and tumors in the region of mandibular condyles, remodeling and arthritic conditions, endocrine disturbances and radiation.

Degenerative Joint Disease (DJD) is a non inflammatory disorder of joints characterized by joint deterioration and proliferation. Joint deterioration is characterized by loss of articular and bone erosion. The proliferative component is characterized by new bone formation

at the articular surface and subchondral region. Sclerosis of bone, subcondylar cysts, and osteophyte formation is seen [51]. In mild to moderate DJD, TMJ is asymptomatic but arthritic changes are observed on radiographs. Radiographic findings in degenerative joint disease may include narrowing of the joint space, irregular joint space, flattening of the articular surfaces, osteophytic formation, anterior lipping of the condyle and the presence of Ely's cysts [16,52,53]. These changes may be seen best on tomograms or CT scans [16,54].

A study which analyzed the relationship between TMJ related pain and morphological change of the TMJ revealed that pain on lateral palpation may be related to the pathological conditions that induce resorption of the lateral part of the condyle [55].

Erosions of the condyles present in Rheumatoid arthritis, Psoriatic arthritis, septic arthritis and Gouty arthritis [51,56-60].

Unilocular or multilocular radiolucency is observed in aneurismal bone cyst, Ganglion cyst of the condyle [61-64]. Few cases have been reported of simple bone cyst affecting mandibular condyle [65,66].

Among tumors osteoma, osteochondroma, chondroblastoma, Ewing's sarcoma, osteosarcoma, chondroblastoma were found affecting the condylar morphology [67-73]. In 2005, it was reported that only six cases of peripheral osteoma affecting mandibular condylar was described in literature [67]. A review of literature revealed 29 cases of mandibular condyle osteochondroma [68,69].

In cases of trauma condyle eventually may show degenerative changes (flattening, erosion, osteophyte) and ankylosis [16]. Morphology of condyle is altered in case of radiation therapy due to growth arrest [74].

The appearance of mandibular condyle varies greatly among different age groups and individuals. Human mandibular condyles may be categorized into five basic types: flattened, convex, angled, rounded and concave. Morphologic changes of condyle occur due to developmental variations, remodeling, various diseases, trauma, endocrine disturbances and radiation therapy. Among various imaging modalities used for TMJ imaging panoramic radiographs still remains the main screening modality for TMJ abnormalities. Radionuclide bone scanning is a useful technique for showing early functional and biochemical bone changes. CT images are highly accurate for osseous abnormality. Cone-beam computed tomography images are superior over others for the bony morphology of mandibular condyles. MRI is the examination of choice in evaluating TMJ soft tissue changes. Genetic, acquired, functional factors, age groups, individuals have a role in morphologic changes of condyle. Thus variability in the shapes and sizes of condyles should be an important factor in diagnosing the disorders of temporomandibular joint.

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