Basilar invagination diagnosis

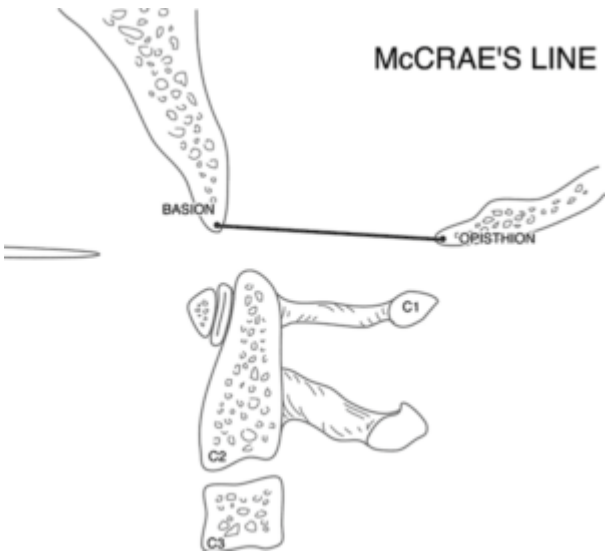
- Atlantoaxial instability in Chiari formation- an analysis based on static and dynamic head imaging in 35 patients
- Basilar Invagination Diagnosis, Classification, and Radiology: WFNS Spine Committee Recommendations
- Mapping, classification, and surgical strategy for vertebral artery variation in posterior atlantoaxial joint release, distraction, and fusion surgery for basilar invagination and atlantoaxial instability
- The head position and cervical alignment in patients with Chiari malformation: A retrospective case-control study
- Craniovertebral Junction Anomalies: World Federation of Neurosurgical Societies Spine Committee Recommendations Overview
- A new technique: endoscopic transmass odontoidotomy
- C2 anatomical pedicle screw for C2 fixation under the concept of atlantoaxial joint distraction and fusion with intra-articular cages: technical note
- Cervical spine considerations in Goldenhar syndrome: a clinical perspective

Basilar invagination is diagnosed by various imaging modalities such as plain x rays, CT scans, and MRI.

Quantitated by measuring the basal angle, which on plain x-rays, measured the angle between lines drawn from the nasion to center of sella and then to the anterior foramen magnum, [1] but on MRI was felt to be better represented by the angle between a line drawn along the floor of the anterior fossa to the dorsum sellae and a second line drawn along the posterior clivus. [2] Normal mean basal angle: 130°. Platybasia: >145° (abnormally obtuse basal angle).

Measurements used in BI

1. McRae's line:



Drawn across foramen magnum (tip of clivus (basion) to opisthion) [3]. The mean position of the odontoid tip below the line is 5 mm (± 1.8 mm SD) on CT and 4.6 mm (± 2.6 mm SD) on MRI [4].

No part of odontoid should be above this line (the most accurate measure for BI)

Chamberlain’s line

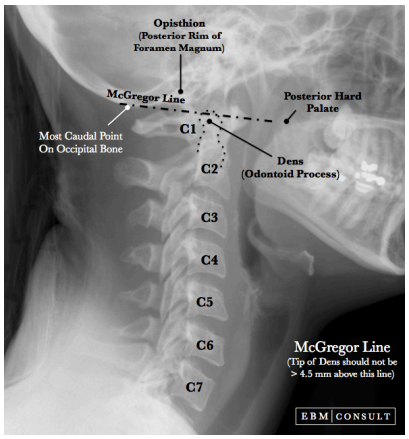
2. Chamberlain’s line [5]:

Less than 3 mm or half of dens should be above this line, with 6 mm being definitely pathologic. Seldom used because the opisthion is often hard to see on plain film and may also be invaginated. On CT [6] and MRI [7] the normal odontoid tip is 1.4 mm (± 2.4) below the line

see Chamberlain’s line for Basilar invagination diagnosis

---

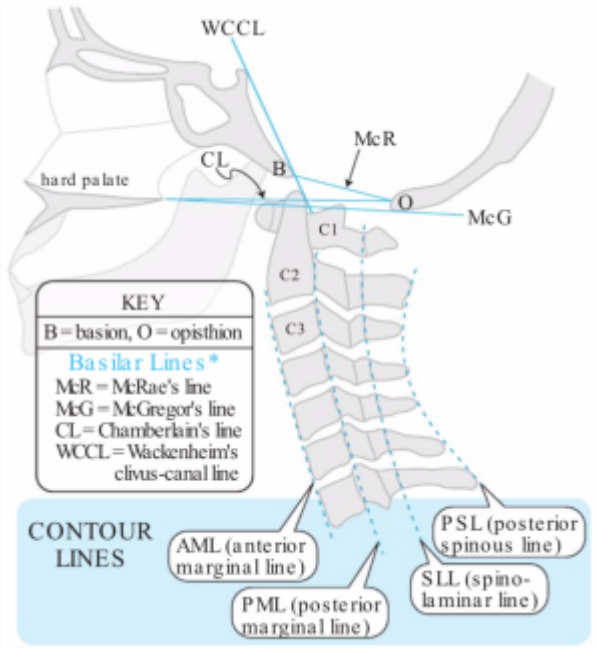
3. McGregor’s line:



http://www.ebmconsult.com/content/images/Xrays/McGregor_Line.png

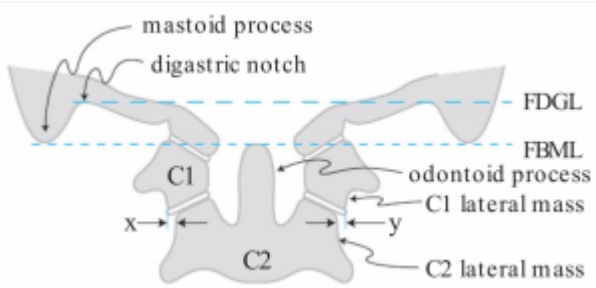
It refers to a line connecting posterior edge of the hard palate to the most caudal point of the occipital curve. If the tip of the dens lies more than 4.5 mm above this line it is indicative of basilar invagination.

4. Wackenheims line



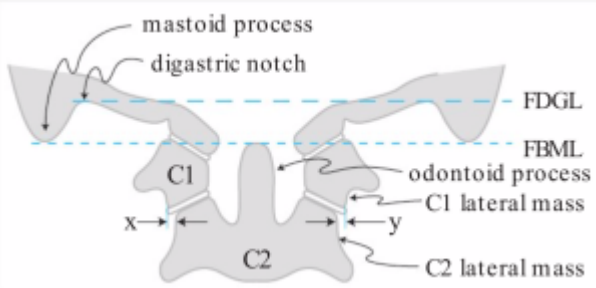
Normally the tip of the dens is ventral and tangential to this line. In basilar invagination odontoid process transects this line.

5. Fischgold's digastric line



joins the digastric notches.The normal distance from this line to the middle of the atlanto-occipital joint is 10 mm (decreased in BI) [8].

6. Fischgold's bimastoid line



joins tips of mastoid processes. The odontoid tip averages 2 mm above this line (range: 3 mm below to 10 mm above) and this line should cross the atlanto-occipital joint.

Foramen Magnum Angle

The foramen magnum angle (FMA), which is formed by the Chamberlain's line and McRae's line, has

not been fully studied. The study aimed to investigate the FMA and its relationship with other craniocervical parameters.

Participants were divided into control, type A BI, and type B BI groups. Parameters included Chamberlain line violation, atlantodental interval, clivus height, clivus anteroposterior dimension, FMA, basal angle, clivo-axial angle, head and neck flexion angle, Boogard's angle, and subaxial cervical spine lordosis angle. A comparison of these parameters among the 3 groups and correlation analysis between FMA and other parameters were performed. The significance level was set at $P < 0.05$.

A total of 111 controls, 111 type A BI patients, and 62 type B BI patients were enrolled. The FMAs in the control, type A BI, and type B BI groups were 6.21° (3.67°, 8.71°), 22.16° ± 6.61°, and 22.39° (17.27°, 31.08°), respectively. Correlation analysis revealed correlations between the FMA and other variables. In the 2 BI subgroups, FMA was significantly correlated with Chamberlain line violation, clivus height, clivus anteroposterior dimension, basal angle, clivo-axial angle, and Boogard's angle.

The FMA in patients with BI was approximately 22° and approximately 6° in controls, indicating that the foramen magnum in BI had a greater tilt. As a pathological condition, FMA can reflect the degree of BI. Clivus hypogenesis is a reason for the excessive tilt of the FM [9)]

Basilar impression diagnosis in rheumatoid arthritis

Erosion of the tip of the odontoid, commonly seen in rheumatoid arthritis (RA), obviates use of any measurement that is based on the location of the tip of the odontoid [10)]. For this reason, other measures have been developed, including the Clark station, [11)].

Redlund-Johnell criteria, [12)] and Ranawat criteria [13)]. Since even these methods will miss up to 6% of cases of BI in RA, [14)], it is recommended that suspicious cases be investigated further (e.g.with CT and/or MRI).

MRI: optimal for demonstrating brainstem impingement, poor for showing bone.

Cervicomedullary angle: the angle between a line drawn through the long axis of the medulla on a sagittal MRI and a line drawn through the cervical spinal cord. The normal CMA is 135 – 170 ° . A CMA < 135 ° correlates with signs of cervicomedullary compression, myelopathy or C2 radiculopathy [15)].

CT: primarily done to assess bony anatomy (erosion, fractures…).

CTA should be performed when surgery is contemplated, to show detail of VA anatomy.

Myelography (water soluble) with CT: also good for delineating bony pathology.

References

1)
Poppel MH, Jacobson HG, Du BK, Gottlieb C. Basilar impression and platybasia in Paget's disease. Br J Radiol. 1953; 21:171–181
2)
Koenigsberg RA, Vakil N, Hong TA, Htaik T, Faerber E, Maiorano T, Dua M, Faro S, Gonzales C.

Evaluation ofplatybasiawithMRimaging.AJNRAmJNeurora- diol. 2005; 26:89–92
3)

McRae DL. The Significance of Abnormalities of the Cervical Spine. AJR. 1960; 70:23–46
4) , 7)

Cronin CG, Lohan DG, Mhuircheartigh JN, Meehan CP, Murphy JM, Roche C. MRI evaluation and measurement of the normal odontoid peg position. Clin Radiol. 2007; 62:897–903
5)

Chamberlain WE. Basilar Impression (Platybasia); Bizarre Developmental Anomaly of Occipital Bone and Upper Cervical Spine with Striking and Mis- leading Neurologic Manifestations. Yale J Biol Med. 1939; 11:487–496
6)

Cronin CG, Lohan DG, Mhuircheartigh JN, Meehan CP, Murphy J, Roche C. CT evaluation of Chamberlain's, McGregor's, and McRae's skull-base lines. Clin Radiol. 2009; 64:64–69
8)

Hinck VC, Hopkins CE, Savara BS. Diagnostic Criteria of Basilar Impression. Radiology. 1961; 76
9)

Jian Q, Zhang B, Jian F, Bo X, Chen Z. Basilar Invagination: A Tilt of the Foramen Magnum. World Neurosurg. 2022 Aug;164:e629-e635. doi: 10.1016/j.wneu.2022.05.027. Epub 2022 May 14. Erratum in: World Neurosurg. 2022 Nov;167:255. PMID: 35577208.
10) , 14)

Riew KD, Hilibrand AS, Palumbo MA, Sethi N, Bohlman HH. Diagnosing basilar invagination in the rheumatoid patient. The reliability of radiographic criteria.J Bone Joint Surg.2001; 83-A:194–200
11)

Clark CR, Goetz DD, Menezes AH. Arthrodesis of the Cervical Spine in Rheumatoid Arthritis. J Bone Joint Surg. 1989; 71A:381–392
12)

Redlund-Johnell I, Pettersson H. Radiographic measurements of the cranio-vertebral region. Designed for evaluation of abnormalities in rheumatoid arthritis. Acta Radiol Diagn (Stockh). 1984; 25:23–28
13)

Ranawat CS, O'Leary P, Pellicci P, et al. Cervical Spine Fusion in Rheumatoid Arthritis. J Bone Joint Surg. 1979; 61A:1003–1010
15)

Bundschuh C, Modic MT, Kearney F, Morris R, Deal C. Rheumatoid arthritis of the cervical spine: surface-coil MR imaging. AJR Am J Roentgenol. 1988; 151:181–187