Co-existence of Bilateral Caroticoclenoid Foramen with Bilateral Absence of Mental Foramen in an Adult Human Skull; An Extremely Rare Variation

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Abstract
Descriptive skull anatomy and morphological variations occurring in its important foramina have a profound effect on the development of modern neurosurgery. Variations in skull foramina usually occur in the form of duplication, multiplication and partial or complete absence. This case report describes two extremely rare foramen variations occurring simultaneously in a dry human skull; presence of bilateral carotico-clenoid foramen and bilateral absence of the mental foramen.

Key Words
Carotico Clenoid Foramen, Mental Foramen, Anatomic Variation

Introduction
The interior of the base of skull is divided into 3 fossae viz. anterior, middle and posterior cranial fossae. The anterior cranial fossa extends from frontal bone anteriorly to lesser wing of sphenoid posteriorly and lodges the frontal lobes of cerebral hemispheres. The lesser wings of the sphenoid end medially to form eminences termed as anterior clinoid processes which are attached anterior end of free margin of tentorium cerebelli. The middle cranial fossa is butterfly shaped and formed in the centre by body of the sphenoid. Anteriorly this surface is smooth and is termed as jugum sphenoidale. Traced posteriorly, it presents sulcus chiasmaticus, tuberculum sellae, sella turcica and dorsum sellae. The anterior boundary of sella turcica is completed laterally by 2 small eminences, the middle clinoid processes, which also form the anterior end of the medial boundary of the groove for internal carotid artery. The superolateral angles of dorsum sellae end in 2 tubercles of varying size called the posterior clinoid processes which give attachment to the fixed margin of tentorium cerebelli. Notable foramina in middle cranial fossa include foramen rotundum, ovale, spinosum and lacerum/carotid canal and optic canal. The posterior cranial fossa is deep, lying posterior to petrous temporal, formed greatly by squamous part of occipital bone and lodges the cerebellar hemispheres. The norma frontalis aspect of skull presents the mental foramen as an oval or circular opening on the anterior surface of the mandible; through which the mental bundle (mental nerves and vessels) exits and innervates the ipsilateral chin, lower lip and gingiva. Mental foramen is the determinant of the mental triangle and forms an important landmark of the human mandible.

Case Report
An average sized, partially edentulous adult female dry skull of Asian origin, age 56 years was identified during routine class tutorials as presenting with two extremely rare anatomic variations simultaneously; presence of bilateral carotico-clenoid foramen and bilateral absence of mental foramen. (Fig 1) CT scan reports showed normal bone density and absence of any major trauma, invasive physical injury, senile resorption or fibrosis in the skull. Citings of the conditions stated above are ‘few and far between’ in medical literature and their parallel occurrence in the same skull is an exceptional incidence which merits reporting. To the best of authors knowledge, no similar case with concurrent coexistence of both anomalies in the same skull has been cited before in medical literature.

Anomaly #1 Bilateral Carotico-Clenoid Foramen
The anterior and middle clinoid processes of both sides were linked by a thin bony bridge, thus forming a foramen termed as foramen clinoideo-caroticum bilaterally. (Fig 2A,B, C) The foramen were large and circular with a smooth outline. They were located anterolateral to the
sella turcica, medial to the superior orbital fissure and behind the optic canal on both sides. The maximum dimensions of the foramen were 5.2 mm horizontal and 5.1 mm vertical on right side and 4.5 mm horizontal and 4.4 mm vertical on left side. There was no tendency of fusion between anterior and posterior or between middle and posterior clinoid processes of either side.

**Anomaly #2  Bilateral Absence of Mental Foramen**

The mandible showed normal gross morphology in all aspects except for bilateral absence of mental foramen. The foramen were bilaterally symmetrical and the mandibular canal was patent to a distance of 3.2 cm and 3.5 cm on the right and left sides respectively as determined by steel wire probe.

**Discussion**

The caroticoclinoid foramen is an inconstant structure formed by ossification of a fibrous ligament between the anterior clinoid process and middle clinoid process. Caroticoclinoid foramen has been observed in fetal skulls and children (1,2) but is usually absent in adults. Its presence in the dry adult skull is considered an anatomic variation and represents ossification of the fibrous interclenoid ligament. The caroticoclinoid foramen allows the passage of one of six segments of the internal carotid artery, the clinoidal segment. The internal carotid artery passes through the caroticoclinoid foramen as it turns upwards to supply brain. This is the only mention made by text book authors like Dubrul, Williams. No other prominent text books of anatomy; Anson, Thorek, Hamilton, Lockhart or McMinn have even touched this topic. Even Dubrul, Williams are unvoiced about its prevalence and its bilateral presentation (3). While on one hand, a wide foramen may provide a safety cover for the artery, on the other hand, it may confuse radiologists doing carotid arteriograms and pose accessibility and hemorrhage problems during neurosurgical invasive procedures of the region like anterior clinoectomy. The foramen may cause narrowing of the internal carotid artery, giving rise to headaches and other compression symptoms as usually there are discrepancies between diameters of the artery and foramen; the former being larger. Erturk et al and Das et al. have shown the presence of morphological changes in internal carotid artery in almost all cases of caroticoclinoid foramen (4,5). Studies affirm that the position of the caroticoclinoid foramen in an area close to the cavernous sinus may change the dimensions of the intracavernous area (6,7). Unilateral and incomplete caroticoclinoid foramina are a relatively more common occurrence (range 8 to 35%) than bilateral and complete foramina (range 0.2 to 4%) (8-11). Their incidence exhibits racial trends, with high reportings in Turkish, Portugal, Nepalese and low in Brazilian, Korean and Indian skulls (8,9). While no statistical differences have been observed in the occurrence of foramen between right and left sides or age (11); in relation to sex, the foramen in female skulls are significantly higher than male skulls (8). The foramen observed in this case had an average diameter of 5.2 mm on the right and 4.5 mm on the left side, results similar to those reported by others. (4,12,13). The foramina reported here are unique and their knowledge may be
equally useful for radiologists, endocrinologists, neurosurgeons and biological anthropologists.

The mental foramen is an oval or circular opening on the anterior surface of the human mandible, through which the inferior alveolar nerves and vessels, after passing through the inferior alveolar canal, exit as mental nerves and vessels. It is a morphologically and clinically important landmark for anatomists, dentists and orthognatic surgeons alike. Available literature indicates that the common position of the mental foramen is below or between mandibular premolars. Variations in foramen number (multiple or absent foramen) and modal location (subcanine to submolar) are often encountered and hold important neurovascular implications (14). Absence of mental foramen as reported in this case is a very rare anatomic variation. Although sufficient objective evidence is unavailable, such persons could possibly present with some degree of neurosensory / sensorymotor disturbance in the mental region and around lips due to this rare condition. The incidence of absence is equal between Caucasians and Blacks; no particular racial trend has been observed regarding this phenomenon (14). The frequent reasons for actual mental foramen absence may range from atrophy, post traumatic fibrosis, osteoblastic hyperplasia, geriatric bony resorption or congenital agenesis. Interestingly, man is the only primate known to have agenesis of the mental foramen and accessory foramina are a far more common occurrence than absence. False radiographic reportings account for a majority of cases of apparent absence. Very few citations of mental foramen absence are available in literature. (incidence being 0.2% to 0.47% for unilateral absence and as low as .001 to 0.02% for bilateral absence) (14) Between 1968 to 1979, just 6 cases of unilateral absence have been reported; 1 each by Inke (1250 mandibles in 1968), Azaz (105 mandibles in 1973) and D Feritas (275 mandibles in 1976) and 3 cases again by D Feritas later in 1979 among 1435 mandibles (15-17). A single case of bilateral absence was reported by Hasan et al (18) in 2010. Other than this, no other reports are available; which reflects the extreme rarity of the condition. A thorough knowledge of the mental foramen anatomy and its commonly occurring morphologic variations can significantly reduce the incidence of positional misjudgments in clinical dentistry and post surgical parasthetic, paralytic and hemorrhagic complications of the mental region.

The foramen variations reported here; bilateral carotico-cloind and absent mental foramen are very rare and may not be routinely encountered during clinical procedures. However, knowledge of their presence holds strategic importance for increasing the success and safety of regional surgery, reducing chances of misdiagnoses, positional misjudgments, relieving irritating neurovascular symptoms, atypical sensory syndromes, functional impairment and reducing post procedural hemorrhagic or paralytic complications.

References