



Original Article

Ossified ligaments in relation to foramina and bony landmarks of the middle cranial fossa



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ARTICLE INFO

Article history:

Received 18 June 2017

Accepted 8 March 2018

Available online 9 March 2018

Keywords:

accessory foramina
middle cranial fossa (MCF)
ossified ligament
skull base surgery

ABSTRACT

Introduction: Sporadic reports on individual ossified ligaments of the middle cranial fossa (MCF) fail to do justice to their grave clinical consequences. The present study attempts a comprehensive search for all ossified ligaments and associated accessory foramina in relation to MCF, in order to standardize baseline prevalence pertinent for the Indian subcontinent.

Methods: Fifty well-preserved and intact, adult (age >20 yrs), dry, macerated skulls were obtained from the Anatomy departments of medical colleges in Delhi, including the All India Institute of Medical Sciences. All the skulls were subjected to a meticulous, bilateral examination and digital photography of internal & external aspects of the skull base, to look for presence of partially or completely ossified ligaments and resulting accessory foramina.

Results: The incidence values recorded from the present sample ($n=50 \times 2$) for completely (C) and incompletely (IC) ossified MCF ligaments are as follows: Caroticoclinoid: C=6 (6%), IC=2 (2%); Interclinoid: C=3 (3%), IC=2 (2%); Pterygospinous: C=2 (2%), IC=3 (3%); Pterygoalar: C=1 (1%), IC=2 (2%); Petrosphenoid/petroclinoid: C=2 (2%), IC=0 (0%). All completely ossified ligaments were found to be associated with accessory foramina.

Discussion: Presence of ossified MCF ligaments cannot be overlooked in patients with symptoms arising from compression of neurovascular structures and those undergoing skull-base neurosurgery, necessitating pre-surgical screening for presence of calcified ligaments in close proximity to vital structures – a scenario that may influence surgical outcome.

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1. Introduction

Ossified ligaments in relation to the skull base, especially when associated with vital structures crowding the middle cranial fossa (MCF) may have grave clinical implications^{1–3}. They may compress⁴ or entrap^{5,6} closely related neurovascular structures leading to clinical sequelae of variable magnitude. They may also obstruct surgical and anesthetic approaches aimed at these critical neurovascular structures³. When completely ossified, they often form new, accessory foramina surrounded by the ossified ligaments and closely placed bony prominences to which they are attached, with a potential to create constrictions around neurovascular structures passing in the vicinity^{7,8}. The possibility of this being causally related to the observed clinical picture is difficult to diagnose and often gets overlooked³.

On undertaking a comprehensive literature survey, we did not encounter a single study that surveyed all the ossified ligaments and related accessory foramina occurring in the MCF, and correlated their grave clinical implications for the neurosurgeon. We found a few sporadic case reports and surveys on individual occurrence of ossified pterygospinous and caroticoclinoid ligaments. But even individual reports on ossified petroclinoid/petrosphenoid, interclinoid and pterygoalar ligaments in indexed journals were very few. None of these studies reported the incidence of all the MCF ligaments and accessory foramina. Moreover, little or no data obtained from subjects of the Indian subcontinent was found for all these MCF features in standard indexed journals. Each ossified ligament/accessory foramen would have a distinctly characteristic clinical presentation, diagnostic criteria and surgical management, thus underscoring the relevance of a comprehensive study on MCF structures. The present study was designed for this purpose and to fill the above-mentioned gaps in knowledge. The frequency of occurrence of each ossified ligament and accessory foramen found in the present study was compared with that reported in literature, in order to standardize

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baseline data pertinent for Indian subjects. Such a study is important for directing a neurosurgeon's attention towards the possibility of ossified ligaments complicating the planned approach to this immensely complex surgical arena. Since this study is performed on a population with a mixed ethnic heritage^{9–11}, findings of this study may also be generalized to a similar population elsewhere.

2. Materials and methods

Fifty well-preserved and intact, adult (age >20 yrs), dry, macerated skulls were obtained from the Anatomy departments of various medical colleges in Delhi, including the All India Institute of Medical Sciences, following written permission from the respective department heads and due approval from their respective institutional ethics committees. Skulls with gross anomalies (deformities/fractures) were excluded. The skulls are likely to be of Indian ethnicity judging from their sources; however this could not be absolutely confirmed.

All the skulls were horizontally sectioned to remove their calvaria, level with a transverse plane passing 1 cm above the supra-orbital margins & the external occipital protuberance, with the skulls being positioned in the Frankfurt (eye-ear) plane. Each skull was subjected to a meticulous, bilateral examination of internal (MCF) & external (norma basalis) aspects of the skull base, to look for presence of partially or completely ossified ligaments and resulting accessory foramina in the MCF. The ligaments and foramina observed were duly recorded using digital photography.

The findings were tabulated as the number of complete (C) and incomplete (IC) ossified ligaments observed on each side, and the total number of each partially or completely ossified ligament was computed as a percentage of the total sample size ($n = 50 \times 2$). Data was matched for completely ossified ligaments and the accessory foramina created by them.

3. Results

The following 5 ossified ligaments and accessory foramina were observed in relation to the MCF, the first three seen within the

internal aspect of the fossa and the last two detected on the outer aspect of the skull base:

1. Caroticoclinoid ligament (Fig. 1): a partial or complete osseous bar uniting the anterior and middle clinoid processes on one/both sides, resulting in the formation of the caroticoclinoid foramen within the MCF.
2. Interclinoid ligament (Fig. 2): a partial or complete osseous bar uniting the anterior and posterior clinoid processes on one/both sides, resulting in the formation of an accessory interclinoid foramen across the middle of the carotid groove within the MCF.
3. Petrosphenoid/petroclinoid ligament (Fig. 3): a partial or complete osseous bar uniting the anterior/posterior clinoid processes with the petrous apex on one/both sides, resulting in the formation of the petrosphenoid/petroclinoid foramen within the MCF.
4. Pterygospinous ligament (Fig. 4): a partial or complete osseous bar uniting the lateral pterygoid plate with the base of spine of sphenoid bone on one/both sides of the outer aspect of the skull base running close to the foramen ovale, resulting in the formation of the pterygospinous foramen (*foramen pterygospinale*).
5. Pterygoalar ligament: a partial or complete osseous bar uniting the lateral pterygoid plate with the greater wing of sphenoid on one/both sides of the outer aspect of the skull base running close to the foramen ovale, resulting in the formation of the pterygoalar foramen (*foramen crotaphitico-buccinatorium*).

The values recorded from the present sample ($n = 50 \times 2$) for completely (C) and incompletely (IC) ossified ligaments in relation to MCF have been tabulated (Table 1). All completely ossified ligaments were found to be associated with accessory foramina (Table 2).

4. Discussion

The clinical consequences of ossified ligaments of the skull base have escaped surgeons' attention and remained poorly understood for several decades. The increasing use of endoscopic and stereotaxic surgical approaches however, is steadily changing clinical perceptions regarding their importance. It seems

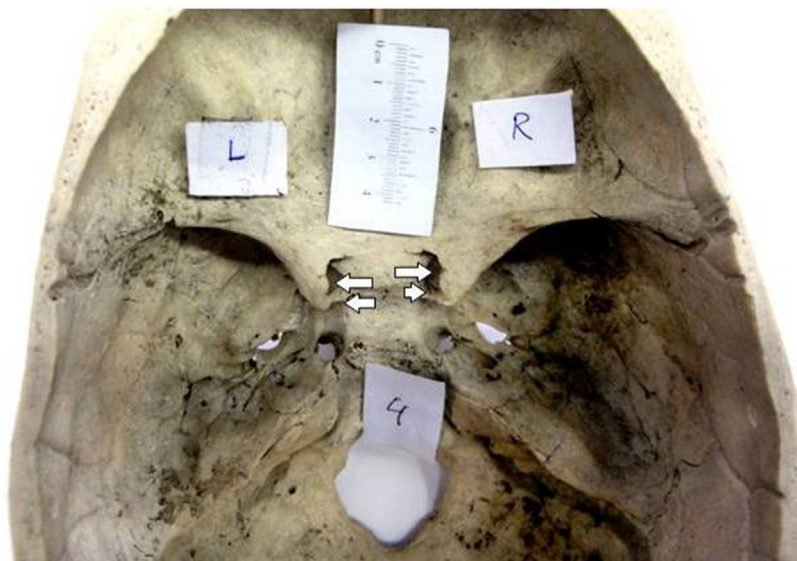


Fig. 1. Bilateral completely ossified caroticoclinoid ligaments and resulting accessory foramina. [Ossified ligaments are indicated by short arrows and accessory foramina by long arrows]

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