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The clinical significance of the petroclinoid ligament

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This report describes the topography and structure of the petroclinoid ligament with reference to its clinical significance. Observations of this ligament were performed on 24 sections of human heads. Remnants of the ossified form of this ligament were sought in 73 dry human skulls. It was found that the petroclinoid ligament existed as an anterior and posterior fold of the dura mater and stretched from the petrous apex and the anterior and posterior clinoid process respectively. We assessed the close proximity of this ligament to the oculomotor nerve. In one case we found a partially ossified posterior petroclinoid ligament, which appeared as a bony spike that arose posteriorly and inferiorly from the posterior clinoid process.

Key words: petroclinoid fold, dura mater, paraclinoid region

INTRODUCTION

The petroclinoid ligament is a fold of the dura mater that extends between the anterior and posterior clinoid processes and the petrosal part of the temporal bone. Thus there are two separate bands, which are termed the "anterior" and "posterior" petroclinoid ligaments respectively. The anterior petroclinoid ligament is considered to be an extension of the tentorium cerebelli, while the posterior petroclinoid ligament arises from posteromedial extensions of the tentorial notch. Both ligaments limit the basin of the hypophyseal region. The anterior petroclinoid ligament limits laterally the superior wall of the cavernous sinus, and the posterior petroclinoid ligament limits its posterior wall. The angle between the two petroclinoid ligaments may vary from 20° to 55°, but the most frequent angles are between 30° and 50° [7, 19].

The posterior petroclinoid ligament is a clinically important structure because of its close proximity to the oculomotor nerve. During head trauma it acts as a fulcrum as a result of the downward displacement of the brainstem. In consequence, it may cause internal ophthalmoplegia because of injury to the pupillomotor fibres on the ventromedial surface of the oculomotor nerve [8, 10].

The attachment of the petroclinoid ligament across the notch at the petrosphenoid junction forms a foramen, which contains the abducent nerve. The abducent nerve passes inferiorly to the petroclinoid ligament [12, 14]. In the case of ventral paraclinoid aneurysms, which originate from the inferior wall of the internal carotid artery, their growth is limited laterally by the petroclinoid ligament [2, 16].

The petroclinoid ligament may calcify, and this is associated with disease entities. Therefore an ossified form of this ligament may create a syndrome, which can be assessed on radiographs [6]. Reddy et al. [15] have pointed out that the ossified petroclinoid ligament is a typical anatomical anomaly, the presence of which serves as a radiographic feature of systemic fluorosis.

Petroclinoid ligaments are rarely described in anatomical literature and books of gross anatomy

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do not always mention these structures [7, 9, 20]. Knowledge of the topographic anatomy of the paraclinoid area is essential for microsurgical management in this region. Therefore we undertook an anatomical study of this ligament in both its normal and ossified condition. The aim of this paper was to present the morphological appearance, topography and effects of ossification of the petroclinoid ligament.

MATERIAL AND METHODS

The petroclinoid ligament was studied on the transverse and sagittal sections of human cadaver heads. We inspected visually the pattern of the bands of dura mater within the middle cranial fossa of 24 specimens fixed in formalin. The interior of 73 human dry crania were observed to discover remnants of the ossified petroclinoid ligament. This was performed by means of a laryngological mirror, which was placed inside the skull via the foramen magnum. Photographs of the mirrored image were taken using a digital camera (Canon EOS D30). The images were then analysed on the computer screen with the aid of graphic software. Images were magnified because the structures of the dural folds were relatively small when viewed in the section.

RESULTS

The petroclinoid ligaments (anterior and posterior) are very delicate bands of the dura matter and thus rarely remain in ossified form in dry skulls. They are composed of collagen and elastic fibres, which are densely packed in fascicles. The anterior petroclinoid ligament was always well visible in all the specimens studied. It was thicker and longer than the posterior petroclinoid ligament, which was hard to recognise. These two dural bands can collectively be termed the petroclinoid ligament (Fig. 1).

Figure 1. Sagittal and horizontal section of the head showing the petroclinoid ligaments (indicated by black arrows); sp — sphenoid bone, tc — tentorium cerebelli, ce — cerebellum.

We observed a close relationship between the oculomotor nerve and the petroclinoid ligament. The oculomotor nerve exhibited a variable trajectory with respect to the axial plane but always traversed the anterior free space of the tentorial hiatus, maintaining potential points of tethering at its brainstem origin, the petroclinoid ligament, and dural insertion. The oculomotor nerve runs under the fold of the dura mater, which stretches between the petrous part of the temporal bone and the lesser wings of the sphenoid bone.

After emerging from the brain, the nerve pierces the dura mater in front of and lateral to the posterior clinoid process, passing between the free and attached borders of the tentorium cerebelli. The oculomotor nerve then passes through the two layers of the dura mater, including the lateral wall of the cavernous sinus. It runs along the superior edge of the lateral wall of the cavernous sinus and enters the superior orbital fissure to access the orbit between the two heads of the lateral rectus (Fig. 2).

Observations of the interior of the skull base provided evidence of ossification that might have

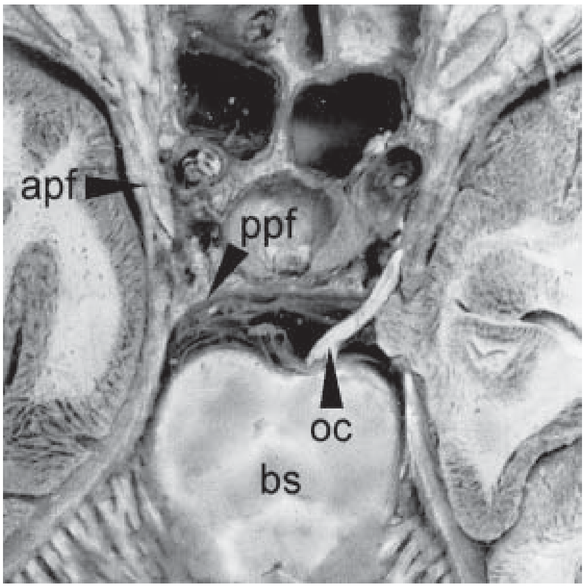

Figure 2. A close-up view of the parasellar region: apf — anterior petroclinoid ligament, ppf — posterior petroclinoid ligament, oc — oculomotor nerve; bs — brain stem.

occurred within the dural folds. In the crania studied we observed specific osseous spikes, which arose from the posterior clinoid process and pointed in a posteroinferior or posterolateral direction. From their appearance they could be regarded as ossified bands of the dura mater, which were normally attached to the posterior clinoid processes and the dorsum sellae. However, we are not able to verify precisely which dural folds were ossified because only small portions were observed. Defined bands of the dura mater had been attached to the posterior clinoid process or dorsum sellae. Taking into account potential anatomical variation, we accepted that some of the bony spikes that extended posteriorly from the posterior clinoid process could be their morphological variants (Fig. 3).

This view can be supported by the observation that these osseous structures are relatively thick bony lamellae, whereas the dural folds are strands of collagen fibres. Even when they calcify, the osseous structure should be rounder and probably less thick than observed in the dry crania. Only in one case were we inclined to attribute this structure to a partially ossified posterior petroclinoid ligament. In appearance it resembles an osseous trabecula that extends posteriorly and inferiorly from the posterior aspect of the posterior clinoid process towards the apex of the petrous bone (Fig. 4). The length of this trabecula was measured as 3.5 mm and the distance

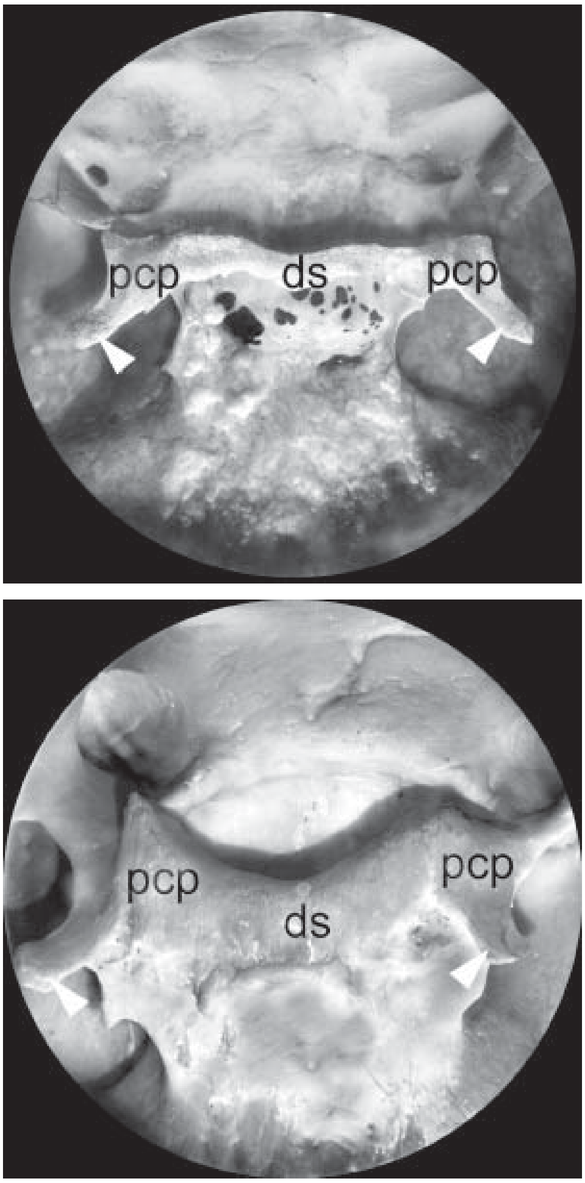

Figure 3. Bilateral posterolateral bony extensions of the posterior clinoid processes (indicated by arrows); pcp — posterior clinoid process, ds — dorsum sellae.

to the petrous apex was 4.5 mm. We did not observe any remnants of ossified anterior petroclinoid ligaments.

DISCUSSION

The morphological appearance and occurrence of the ossified petroclinoid ligament is rarely described in the literature. The aetiology of ossification of the cranial ligaments is not well-known. However, recent observations suggest that it involves genetic and molecular factors. According to Izadi [4], intracranial calcification can appear as normal (physiological)

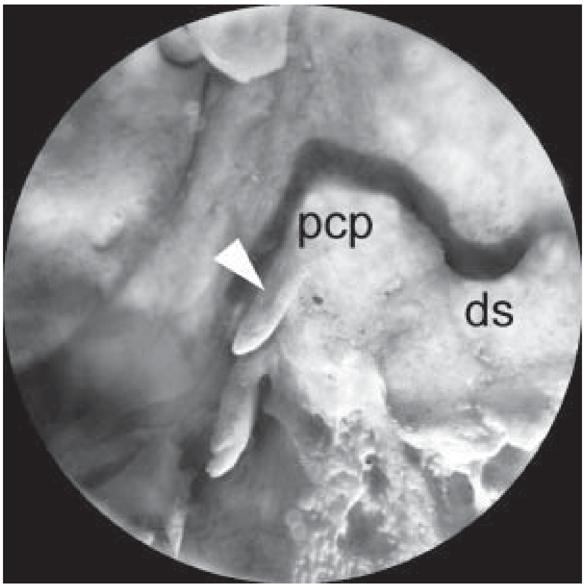

Figure 4. Partially ossified petroclinoid ligament (indicated by arrow); pcp — posterior clinoid process, ds — dorsum sellae.

and abnormal (pathological) processes. In the case of calcium metabolism disorders intracranial calcification is restricted mainly to the brain structures and the dura mater, while the incidence of calcification of the cranial ligaments in this case is relatively low [1, 5, 11, 15, 17]. Kimonis et al. [6] noticed that calcification of the falx cerebri and tentorium of the cerebellum may accompany bridging of the sellae and can be correlated with calcification of other ligaments (the nuchal ligament, for instance).

Cederberg et al. [3] revealed a statistically significant association between calcification of the petroclinoid and interclinoid ligaments. This condition may be attributed to the possibility that both ligaments are portions of the same dural fold. Hence they showed that age may be a significant factor in the risk of ossification of the cranial ligaments. Stanton and Wilkinson [18] found ossification of the petroclinoid ligament in 19.4% of specimens, while a radiographic study of the prevalence of its calcification performed by Cederberg et al. [3] reported that 23% of the petroclinoid ligaments were partially calcified and 9% completely calcified. According to Peker et al. [13] this ligament was observed in an ossified form in 15.8% of male and 4.9% of female dry skulls, but only one of these was completely ossified. Ziyal et al. [21] have noticed that the petroclinoid ligament, should be cut in order to improve mobilisation of the oculomotor nerve, for instance when this is palsied. This procedure minimises the risk of iatrogenic injury as a result of manipulation of the third nerve. The process of ossification can make this neurosurgical practice more difficult.

Although ossification of the petroclinoid ligaments (anterior and posterior) occurs relatively rarely in the human population we would like, in conclusion, to draw attention to the need for neurosurgeons to be aware of potential problems, which may arise during manipulation of the oculomotor or abducent nerves.

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