



Case Report

The middle clinoid process, a variation of parasellar region of sphenoid

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ABSTRACT

Introduction: Middle clinoid process (MCP) is a very important structure in surgeries performed on the parasellar and sellar regions. MCP is a bony eminence located on the body of the sphenoid, posteriorly to the anterior clinoid process and anteriorly to the posterior clinoid process. It becomes clinically important when it reaches the height of at least 1.5 mm. It can form many variations, the most common is the caroticoclinoid foramen.

Aim: To evaluate detailed knowledge, profound understanding of MCP and its role during parasellar region operations.

Case study: During studies at Department of Anatomy, a dry skull specimen projecting bilaterally clinically important MCP was found. This skull belonged to a 60 years old Caucasian male.

Results and discussion: It becomes clinically important when it reaches the height of at least 1.5 mm. The mean height measures 2.59 mm. MCP occurs in about 40% of the population. It can project either unilaterally or bilaterally. No significant differences between age or sex were observed.

Conclusions: Recognition of MCP or its variations on preoperative imaging is crucial for planning endonasal approach in treatment of paraclinoidal ICA aneurysm, pituitary adenomas or clinoidectomies.

1. INTRODUCTION

Presence of the middle clinoid process (MCP) and proper understanding of its localization is of great importance in numerous surgeries being performed with transsphenoidal approach, in which it can be used as a landmark to navigate through cranial structures or it could hinder proper positioning of instruments.¹ If so, an endonasal middle clinoidectomy can be performed in order to enhance access to parasellar region.^{2,3} Thus, knowledge about MCP is crucial to physicians, especially radiologists, doing preoperative diagnostics, and to surgeons. Its clinical relevance starts when the MCP reaches 1.5 mm or more. It can be observed in 37%–42% of a world population.^{1,2,4,5} The middle clinoid process is a bony eminence, of a conical, pointy shape, projecting, in 60% bilaterally, from an anterior part of a body of sphenoid bone, located posteriorly and lightly inferiorly to an anterior clinoid process (ACP) and anteriorly to posterior clinoid process (PCP). The MCP is situated on an anterolateral margin of sellar region, medially to carotid sulcus and internal carotid artery (ICA). It separates parasellar intercavernous ICA from its paraclinoid part and also bespread part of cavernous sinus' roof anteromedially.²

Embryological formation of MCP is the same as of the whole sphenoid bone and sella turcica since it is part of sphenoid.³ During first four weeks of gestation, mesenchyme of the head emerges from two sources – primarily from paraxial mesoderm, but also from the neural crest. Sphenoid forms from mesenchymal cells derived from the latter. Eight weeks later, hypophysial cartilage forms – it makes up the body of the sphenoid bone. At precisely 12 weeks and 4 days of gestation, the process of transforming cartilage into the bone (an ossification) begins.^{6,7}

2. AIM

Our goal is to present a variability of the sellar region of sphenoid bone, which is the presence of the middle clinoid process and its variations. We would also like to discuss their surgical importance, as prior to the surgeries on the sellar region, the knowledge of presence of these bony formations is extremely important.

3. CASE STUDY

In the course of reviewing anatomical dry skull specimens kept in the Department of Anatomy, a skull presenting middle clinoid process bilaterally was found (MCPs are shown with arrows on Figure 1). This specimen derived from a 60 years old Caucasian male donor.

4. RESULTS

Morphometric evaluation of mentioned specimen was carried out. Left MCP (white arrow on Figure 1) measured



Figure 1. Examples of anthropogenic sources of EMR.

4 mm in length and had diameter of 2 mm on both sides. Right MCP (black arrow on Figure 1), however, was 2.5 mm in length. MCPs of both sides point straightly, without any curving's. Base of the left MCP in axial plane measured 4 mm, in sagittal 2.5 mm. However, diameters of base of right MCP were 5 mm and 4 mm, respectively. Distances from sagittal midline totaled 12 mm from left and 10 mm from right MCP. Lengths from ACP to the apex of MCP measured 7 mm on the right side, what is roughly 1/3 of lateral bone window (LBW) which was 20 mm. On the left side, measurements of LBW were not possible to be taken, due to damaged ACP. Length of intercarotid distance was 25 mm.

5. DISCUSSION

Knowledge of three dimensional sellar region with emphasis on the MCP is extremely significant for physicians such as radiologists or surgeons in order to improve patients' safety.^{8,9} It is of a great importance while conducting surgical procedures, especially in endonasal transsphenoidal approaches to ICA aneurysms or pituitary gland tumors. Anatomy and variations of ACP and PCP is well described in literature, but MCP is often overlooked.^{1,10,11} Its occurrence could make surgery more challenging, impede proper visualization of surgical field and lesions, and extend chances of complications such as intercavernous sinus haemorrhage

or ICA laceration.⁸ This research aims to evaluate detailed knowledge and understanding of the middle clinoid process.

Akshay Sharma et al. after analysing 2726 skulls, found out that 42% of them presented clinically important MCP. In total, 60% of those presented the structure bilaterally. In unilateral cases, 57% were on the right side and 43% on the left side. In total, 69% of all MCPs were incomplete – they didn't form the caroticoclinoid foramen. The rest was divided into contact and these, which formed full caroticoclinoid foramen. Incomplete MCPs had mean height of 2.59 mm and the diameter at its base of 4.59 mm. Almost all (99%) of MCPs were located in the anterior 1/3 of LBW.⁴ Superior part of the base of MCP was located 6.25 mm posteromedially to the optic strut, whilst width of the optic strut was 4.09 mm.⁴ According to Sharma et al., no significant difference in occurrence of MCP between sexes was noticed.⁴ Nonetheless, according to another study, women presented MCP more frequently (42.7% among women vs 30.7% among men), although the outcome was not statistically relevant.¹ White donors presented MCP in 52% of the cases, whereas black donors in 30% (in both 57% bilateral).⁴ The results correspond with the research conducted by Miller et al. (white ethnicity – 41.3%, black ethnicity – 19.4%).¹ Sharma et al. stated that age of 50 or more indicates higher percentage of incomplete MCP.⁴ On the other hand, Miller et al. reported that there is no significant difference related to age.¹

With regard to Miller et al.'s research 41.8% of MCPs were ring forming, 76.4% were pneumatized. Females had insignificantly higher rate of ring forming (46.9% in females opposed to 34.8% in males).¹ Base diameter of the MCP in the axial plane was 4.6 mm with variation of 1.4 mm.¹ For sagittal plain, the diameter reached 5.0 ± 1.8 mm while the average maximum length of the MCP was 4.7 ± 1.7 mm.¹

MCPs were located 5.9 ± 2.3 mm laterally to the axial midline.¹ It was greater in males (7.0 ± 1.6 mm) than in females (5.2 ± 2.1 mm).¹ The reason for it was not the fact, that male skulls are commonly bigger, since other distances (like sellar-clival junction distance) did not vary significantly.¹

MCP can form 3 shapes: spinous, protruding and cylindrical. The cylindrical type has height equal to maximal longitudinal diameter of LBW.¹² Wang et al. observed MCP in 36.79% of cases, where 16.04% of the subjects had MCP on the left and 20.75% had MCP on the right side).¹² Vast majority of MCPs were situated in the area corresponding with the anterior third of the lower LBW.¹² In some cases, MCP was located in middle third of lower LBW.¹² Yet, in none of the cases was the MCP found in the posterior third of the lower LBW.¹²

Taking mentioned studies into consideration, our specimen had quite short middle clinoid processes, nevertheless both of them were clinically important. Base diameters were more or less average. What is interesting, the structures were located far more laterally than those shown in the research.⁴

A major significance to microsurgery and neurosurgery of parasellar region also proves presence of MCP variabilities and its inclination for forming caroticoclinoid rings (CCr), caused by ossification of caroticoclinoid ligament (CCL).^{3,5,13-15} This variation was registered not only amongst

adults, but also in fetuses and infants.¹⁶ CCr (also known as caroticoclinoid bridge) forms when ligament connecting apexes of MCP and APC ossifies, what can be categorized into 3 types: complete, incomplete and contact.^{3,13} Presence of such structure can hamper access to ICA and cavernous sinus, enhancing risks during treatment of paraclinoid ICA aneurysms, pituitary adenomas or anterior clinoidectomy. Such risks contain lacerating ICA leading to hemorrhage or even brain damage. Existence of the MCP might also limit the extension of parasellar adenoma. This limitation raises for taller MCPs.¹²

In some cases, when CCr is formed, interference with this structure is more challenging, due to proximity to the II, III and IV cranial nerves, ophthalmic artery, ICA and cavernous sinus. In order not to damage those structures, a combined extradural and intradural clinoidectomy is advised.¹⁷ In other cases, the clue is to rule out the CCr.² The endonasal endoscopic middle clinoidectomy may improve visibility of proximal structures, expand surgical field and provide wider range of movement for the surgeon. A proper technique consist of 5 detachments with precise high-speed drilling and removal with small Kerrison rounders.² Although, when CCr is present, it is advised only to reduce MCP.

5. CONCLUSIONS

- (1) Middle clinoid process is a variation of sellar region of sphenoid bone, in accordance to its localization, proximity to ICA and cavernous sinus, it becomes extremely important.
- (2) This case report describes morphometry of sellar region, with emphasis on the MCP of reviewed specimen.
- (3) It also highlights necessity of recognition of middle clinoid process or its variations preoperatively is crucial, because it might create a challenge even for the best surgeons.

Conflict of interest

None declared.

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