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TRANS-FORAMEN MAGNUM EXAMINATION OF THE SELLA TURCICA REGION IN THE MACERATED HUMAN SKULLS

Abstract: This report presents a method of quick and accurate imaging of the sellar region by means of the laryngological mirror equipped with a light pipe and followed by taking digital photograph as the mirror image visible through the foramen magnum. A technique of the intracranial imaging of the osseous structures was tested on the macerated human skulls. Images of the sellar region were presented as the example of quality of the employed technique, which can be regarded as a simplified version of the endoscopic examination.

Key words: visual inspection, digital imaging, sella turcica.

INTRODUCTION

The morphology and variability of the sellar region have been of interest of both of anatomists and clinicians. A particular attention was paid to heterotopic ossification and calcification which occur sometimes in the bands of the dura mater attached to the sphenoid bone [1]. An abnormal appearance of the sella turcica region was usually detected and examined by the radiographic techniques (X-ray pictures or CT-scans) [2, 3]. Also, an anatomical study of the sellar region was performed on dry human skulls after removing the calvaria to reveal interior of the skull [4].

Although computed tomography is in widespread use for clinical imaging, a simple imaging equipment combined with the digital photography can provide satisfactory results for anatomical studies. In some circumstances, the normal or abnormal morphology of the intracranial structures can be presented directly by the digital photography. This modality can show the external appearance of the anatomical structures in natural way, but in the case of the intracranial visualization, the calvaria must be cut off and the lens of the camera approached or even introduced into the cranial cavity. However, dissecting of the skull is a destructive and not always recommended procedure, thereby studying and

imaging of the intracranial morphology become sometimes a problematic task. In fact, visual inspection of the cranial cavity could be also performed by means of the endoscope which can transmit the image to the computer and display it on the screen. Unfortunately, access to such instruments is usually limited because they are intended for a strict medical examination of the living patients.

To overcome these problems a simple optical procedure termed as the trans-foramen magnum photography was worked out in order to visualize quickly the sella turcica region without necessity of removing the calvaria. This paper provides a technical description of the trans-foramen magnum imaging of the sella turcica region, and presents effects achieved by this method.

MATERIALS AND METHODS

Imaging of the sellar region was performed by means of the laryngologic mirror, which was placed in the cranial cavity through the foramen magnum. The image from the mirror was photographed using a digital camera. This procedure was applied to the dry human skulls of the adult individuals.

During photography the skull was placed in upside down position (the foramen magnum was faced upward toward the camera lens). The luminator armed with two flexible, slender light pipes was used as a source of light. (Highlight 3001, Olympus Optical Co.) One of the light pipes was introduced together with the laryngologic mirror via the foramen magnum to the cranial cavity and illuminated region of interest. The second light pipe served as the supplementary light source which was occasionally directed on the area of the foramen magnum. Light reflexes were eliminated or reduced by regulating amount of light and adjusting its direction. High-intensity light was not recommended because it produced glare of the object. Adjustment of appropriate light source was essential to gain satisfactory effects from the trans-foramen magnum photography.

After setting the illumination of the region of interest (e.g. the sellar region) the laryngologic mirror was introduced to the cranial cavity through the foramen magnum, and placed in the position that reflected anatomical structures directly towards the digital camera lens. The diameter of the mirror was adjusted experimentally, and the size of 30 mm proved to be the most satisfactory (Fig. 1). In order to avoid shakes of the mirror during photography the mirror was placed in a solid holder to provide a stable image. However, the holder could change the position in order to set the mirror at the suitable angle. Simultaneous orientation of the laryngologic mirror towards the light source, the region of interest, and the camera position was the other crucial step in the trans-foramen magnum photography.

Next, the camera (Canon EOS 5D) was approached to the plain of the foramen magnum and focused on the mirrored image of the sellar region to shot a sharp picture. Taken pictures were saved in files and subjected to the graphic editing

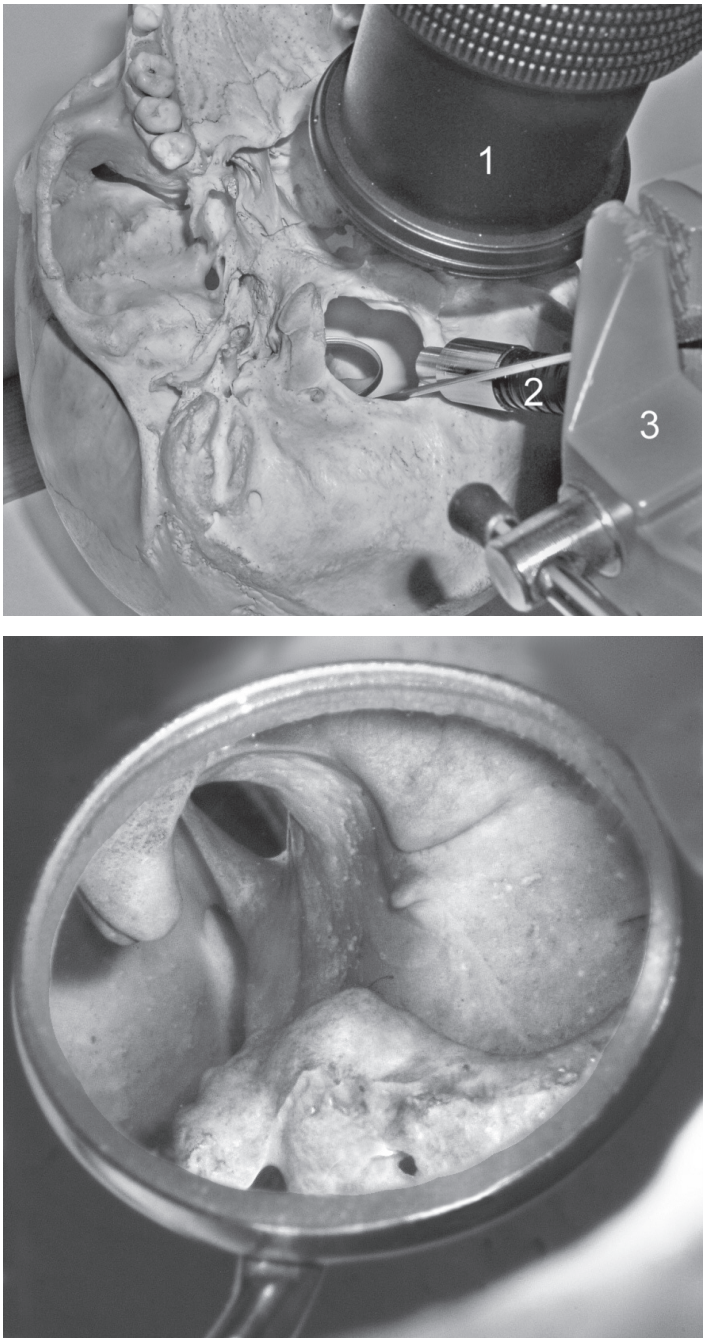


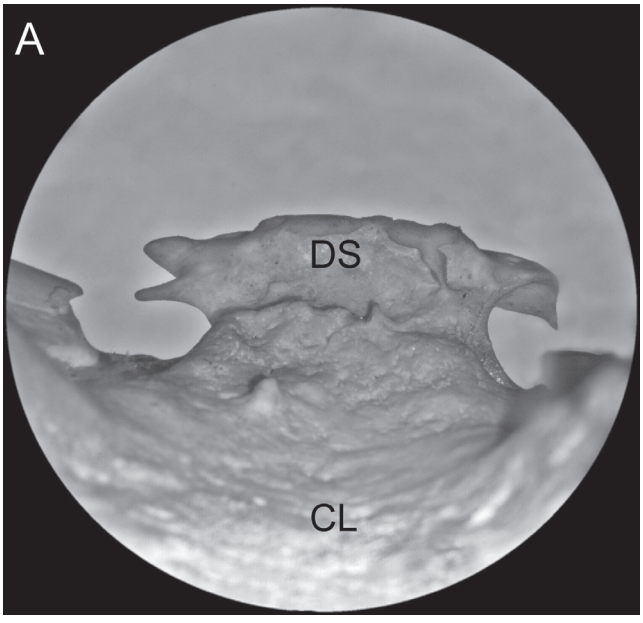
Fig. 1. Equipment for the trans-foramen magnum photography; 1 — camera lens, 2 — flexible light pipe, 3 — holder for the laryngologic mirror (introduced into the cranial cavity). Close-up view of the mirrored image of the sellar region.

program Adobe Photoshop Elements. Application of this software allowed to improved quality of the pictures by enhancing or correcting image data. To obtain natural position of the photographed objects, the image was flipped horizontally to reverse a photographic side in the picture, so that the right and left sides were transposed. This simple image transformation helped to avoid confusion of the side between the observer and the observed object [5, 6].

RESULTS

The observed anatomical details of the sellar region depend on the manner of placement of the laryngologic mirror via the foramen magnum into the cranial cavity. By means of the laryngologic mirror it is possible to observe both the superior and posterior aspect of the sella turcica. Particularly, this technique enables to observe the dorsum sellae, clinoid processes (anterior, middle, posterior) and the clivus. Further, taken pictures of the osseous structures can be subjected to the image analysis or morphometrical study. This allows quickly verify presence of any abnormalities within the sellar region (Fig. 2).

In the case of studied skulls, inspection of the cranial cavity by means of the laryngologic mirror equipped with luminance allowed to perceive ossified bands of the dura mater and bony bridges which occurred between the clinoid processes of the sphenoid bone. Some of them resembled bony trabeculas while the others had the form of the osseous spikes that extended from different parts of the sphenoid bone.



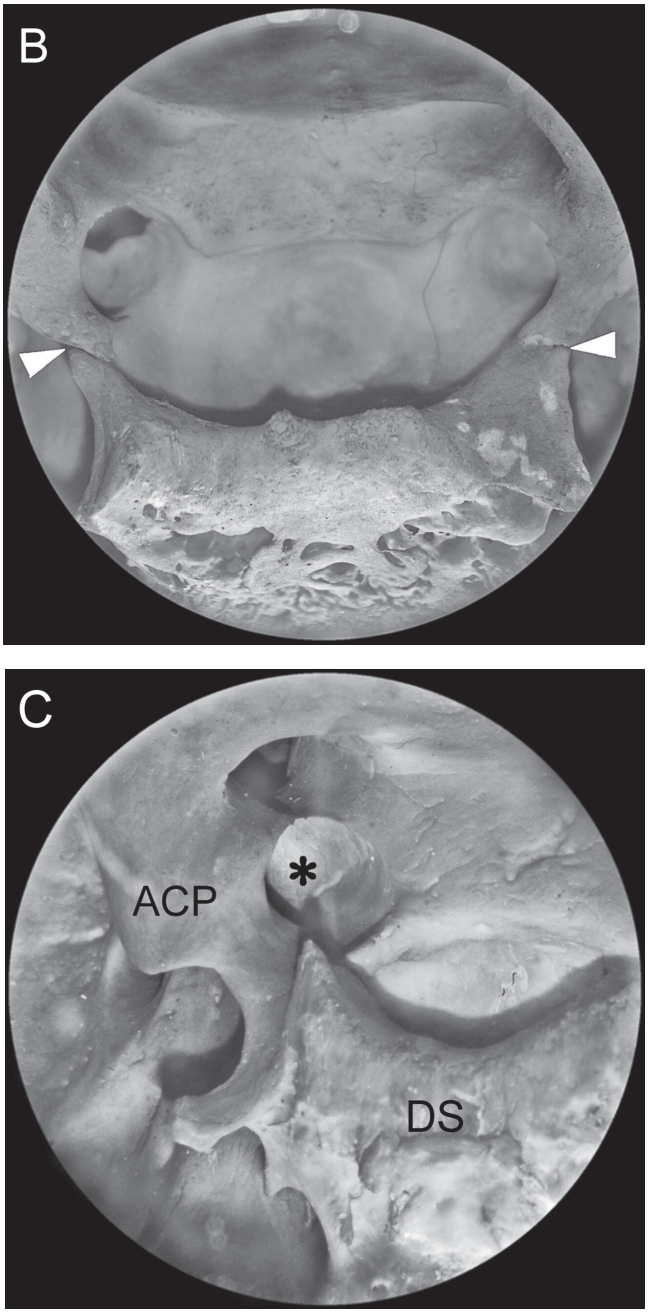


Fig. 2. Examples of trans-foramen magnum photographs of different sellar regions. A — Posterior view of the clivus (CL) and the dorsum sellae (DS). B — Superior aspect of the dorsum sellae; visible bilateral interclinoid bridges (indicated by arrows). C — Detected carototicoclinoid foramen (marked by asterisk); ACP — anterior clinoid process, DS — dorsum sellae.

The trans-foramen magnum photography gave chance to image appearance of the sellar region, and evaluate a degree of ossification of the interclinoid, caroticoclinoid, petrosphenoid and petroclinoid ligaments. This manner of visual inspection allowed easily to observe the accessory osseous formations, which accompanied the dorsum sellae or the clinoid processes, and present morphological changes in this cranial region.

DISCUSSION

The morphology of the sellar and parasellar region has often been studied on radiographs and CT scans [2, 3]. However, the radiological methods of visualisation are time-consuming and require special equipment. Another way of observation of the intracranial structures can be accomplished during cadaver's dissection. Unfortunately, this procedure is strictly limited to the operative field and the surrounding soft tissues may be a handicap in visualisation of the bony structures.

Proposed technique of the trans-foramen magnum visualization allows perceiving all details of external appearance of the sellar region and assessing the degree of abnormal ossification or calcification of the surrounding structures. Unfortunately, direct visualisation of the cranial interior through the foramen magnum can be applied only to the macerated skulls. Thus, this method is only helpful in anatomical or anthropological studies which are performed on the dry cranial collections.

Investigation of the ossified intracranial ligaments observed in the skulls gives information on variability and morphology of these inconstant structures. Morphological appearance, frequency and etiology of the inconstant bony bridges around the sella turcica have been the aim of numerous studies [7–10]. Further, this knowledge was utilized in surgical management and diagnoses of some diseases.

The method of the trans-foramen magnum visualization provides a quick insight into the cranial cavity, and enables to assess anatomy of the sellar region. In this way, one may easily perceive inconstant intracranial osseous forms which result from abnormal ossification or disturbances in the sphenoid bone development.

Effects of the trans-foramen magnum photography depends on some anatomical conditions. One of them is the size and shape of the foramen magnum. The other factor is the degree of the cranial base angulation that may impact on position of the laryngologic mirror which was introduced into the cranial cavity. Essentially, size and shape of the foramen magnum play a crucial role in photography of the sellar region via its lumen. The sagittal diameter of the foramen magnum is usually about 35 mm, while the transverse diameter is 30 mm [11, 12]. Thus, the size of the foramen magnum limits the diameter of the laryngologic mirror which can be introduced through this foramen into the cranial cavity [2, 13].

The trans-foramen magnum photography of the cranial interior becomes difficult if the foramen magnum is small. Than, the field of vision is restricted and it does not always comprise the whole sellar region. A circular or ovoid shape of the foramen is the most convenient to perform the trans-foramen magnum photography, while the elliptic foramen is a troublesome. Coexistence of the small size and elliptic shape of the foramen magnum increase difficulty in taking pictures through the foramen magnum. Fortunately, such a combination of the morphological features is rather rare, and most of the cranial bases facilitate the trans-foramen magnum photography of the sellar region. The above-mentioned circumstances determine extend of the field of vision, and number of anatomical structures which can be captured in a single picture.

The proposed method seems to be helpful in visual inspection of the sellar region and useful in assessing its morphology during anatomical and anthropological studies performed on the macerated skulls. Furthermore, the trans-foramen magnum photography gives chance for a quick searching and documenting anatomical alterations of the sphenoid bone, focusing on the sellar region.

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